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Faculty of Science Course Syllabus
Department of Chemistry
CHEM 3103.03
Intermediate Inorganic Chemistry - Fall 2020

Instructors: Dr. Laura Turculet (lecture) laura.turculet@dal.ca

Dr. Marc Whalen (lab) marc.whalen@dal.ca

*please contact instructors directly **by e-mail** to arrange a virtual appointment, as needed*

Teaching Assistants: Josh MacMillan (lecture) js581967@dal.ca

Kathleen Morrison (lab) kathleenmorrison@dal.ca

Joe Bedard (lab) js830899@dal.ca

Toren Hynes (lab) toren.hynes@dal.ca

On-line Tools: *Lecture Brightspace Site*
CHEM3103 - Intermediate Inorganic Chem. (Sec 1) - 2020 Fall

Laboratory Brightspace Site
CHEM3103 Intermediate Inorganic Chemistry Lab - 2020 Fall

Microsoft Teams (available via Brightspace Lecture site)
for software downloads visit https://libraries.dal.ca/help/software-downloads.html
for IT support visit https://libraries.dal.ca/help/it-help-desk.html

Lectures: All lectures will be available asynchronously on Brightspace

Tutorials (lecture): Mon, Wed 9:35–10:25 am (ADT) (Microsoft Teams; **starting Mon, Sept 14**)
synchronous; attendance is recommended but not required
Tutorial sessions will be recorded and posted on the lecture Brightspace site

Laboratories: 1 session per week (Collaborate Ultra on Brightspace; **starting Sept. 9 & 11**)
synchronous; laboratory participation is required

Office Hours (LT): Fri 9:35–10:25 am (ADT) (Microsoft Teams; **starting Fri, Sept 11**)
synchronous; for questions relevant to lecture component

Office Hours (MW): Wed & Fri 12–1 pm (ADT) (by e-mail to Dr. Whalen)
synchronous; for questions relevant to laboratory component

Course Description

For Fall 2020 this course, including the laboratory component, will be offered exclusively in an on-line format.

Modern bonding theories are developed using symmetry concepts. These are applied to understanding the molecular structure, reactivity, and spectroscopic properties of inorganic compounds, including coordination (transition metal) compounds and organometallic complexes. The laboratory component will provide experience in the interpretation of spectroscopic data (IR, Raman, Uv-Vis, NMR) for the characterization of structural and bonding features in transition metal complexes.

Course Prerequisites

CHEM 2101.03 Introductory Inorganic Chemistry

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Course Objectives/Learning Outcomes

- Understand basic trends in structure and reactivity of transition metal coordination and organometallic complexes
- Acquire a symmetry-based approach to understanding modern bonding models and spectroscopic properties
- Through laboratory application, become familiar with some advanced characterization techniques for structure determination in solution and in the solid state (infrared and Raman spectroscopy, multinuclear magnetic resonance spectroscopy, magnetic susceptibility, visible spectroscopy)

Course Materials

- Required:
  - Inorganic Chemistry, 5th Ed. Miessler, Fischer and Tarr; Pearson, 2014 (e-Text available via Dalhousie Bookstore)
  - Brightspace course websites; **NOTE: separate sites for lecture and lab components**
- Optional:
  - Organic & Inorganic Molecular Model Kit by Darling (available via Dalhousie Bookstore)

Course Assessment

Component	Weight (% of final grade)	Date
Laboratory	25	starts Sept. 9 & 11 see **Laboratory Schedule** for detail
Quizzes (Brightspace)	20	at your own pace; all quizzes due by Dec. 8, 2020 (last day of class); **no make-ups**
Group Projects (5 in total)	40	see **Lecture Schedule** for due dates
Final Exam	15	to be announced

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

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

Course Policies

Class announcements: The instructors will post announcements on the lecture/lab Brightspace sites.

Contacting instructors: Outside of scheduled lecture tutorials (Mon, Wed 9:35–10:25 am ADT) and designated office hours, please contact instructors directly **by e-mail only**. Contacts initiated via other on-line platforms (*e.g.*, Chat functions in Brightspace or Microsoft Teams) cannot be guaranteed a response.

Meeting with the instructors outside of office hours: Please note that outside of office hours, meeting with the instructors is by appointment only. If you wish to set up a (virtual) meeting, please e-mail the instructor(s), clearly indicating the reason you wish to meet as well as your availability. All meetings will utilize Microsoft Teams.

Short-term absence policy: As of January 1, 2018, the university has adopted a **new policy** regarding short-term absences, as detailed here: https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html. In accordance with the new policy, students will no longer submit a sick note or medical certificate in case of a missed academic requirement due to **short-term**

absence (defined as "absence of three (3) consecutive days or fewer due to minor physical or mental health conditions, or other extenuating circumstances such as caregiving duties; immediate family illness, injury or death; involvement in an accident; legal proceedings or being a victim of a crime, domestic or intimate partner violence"). Instead, they will:

(1) notify the instructor by e-mail within 24 h of the missed academic deadline

(2) submit a **Student Declaration of Absence (SDA)** form on-line through the **CHEM3103 lab website** within three (3) calendar days following the last day of absence (NOTE: SDA forms for **both** lab and lecture academic requirements will be **submitted via the lab website**).

Students can use the SDA form **twice** in this course. The submission of the SDA form **does not provide an automatic exemption** from any academic requirements that were missed or late during an absence. Once the form is submitted, course policies will apply regarding procedures for making up the missed academic requirement (see below).

- **Missed laboratory session:** You are expected to attend the laboratory sessions scheduled for the lab section in which you are registered (see below). Students cannot attend a different laboratory session unless prior arrangements have been made with the instructor. After submittal of the SDA form for a short-term absence, it is at the discretion of the instructor as to whether or not the lab can be performed at another time.
- **Late/missed submittal of a laboratory quiz, group project, or final exam:** For each weekday after the posted due date, 10% will be deducted. A submitted SDA form will excuse one day late past the last day of short-term absence (unless alternate arrangements are made with the instructor).

If serious circumstances, such as illness, result in student absence for an extended period of time (*e.g.*, >3 consecutive days) and in missing of multiple academic deadlines, students should contact Patricia Laws, Assistant Dean of Student Affairs (Scieasst@Dal.Ca) as promptly as possible to make alternate arrangements.

Attending your lab section: You are registered for one of the lab sections below. You must attend the lab section for which you have registered (on-line via Microsoft Teams). **Attendance is required and discussion participation will comprise 10% of the laboratory grade.**

Lab Sections: **Section B01** - Wednesday, 1:30 pm ADT (Microsoft Teams)

Section B03 - Friday, 1:30 pm ADT (Microsoft Teams)

Registering for a different lab section: Students can change laboratory sections on-line until 5pm, Friday September 11 (end of 1st week of classes).

Attending a lab day other than the one you are registered for: You are expected to attend the laboratory sessions scheduled for the lab section in which you are registered (see **Laboratory Schedule** below). Students cannot attend a different laboratory session unless prior arrangements have been made with the instructor. In case of illness or other circumstances that affect your ability to attend lab, please consult the **Short-term absence policy** (above), and submit a **Student Declaration of Absence (SDA)** form through the lab website within (3) calendar days following the last day of absence. It is at the discretion of the instructor as to whether or not the lab session can be performed at another time.

Lab preparation: Students are expected to come to the lab discussion session having completed adequate preparation in advance according to the guidelines stated in the **Laboratory Schedule**.

Laboratory exemptions: If you have taken this course before, you may apply for a lab exemption. To do so, contact Dr. Whalen by e-mail prior to the first day of lab (Sept. 9). Lab exemptions are at the discretion of the instructor and must be applied for. The student should not assume that such an exemption will be granted without applying.

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CHEM 3103 On-line Delivery Protocol (Lecture Component)

- The lecture component of this course will be delivered via **pre-recorded lectures** available asynchronously on the Brightspace lecture site.
- **Assigned reading** from the textbook (Inorganic Chemistry, 5th Ed. Miessler, Fischer and Tarr) will complement the lecture material.
- **Practice problems and associated solutions** relevant to each week's lecture material will be made available on Brightspace, and these problems will be taken up during twice weekly, interactive **tutorial sessions** that will be **delivered synchronously** during assigned lecture periods (Mon and Fri 9:35-10:35 am ADT) via Microsoft Teams.
- Attendance at the lecture tutorials is strongly recommended but is **not mandatory**. Live tutorial sessions will be **recorded and posted** on the Brightspace lecture site for subsequent viewing. The tutorial sessions will involve some amount of **lecture material recap**, and will provide a forum for asking questions and getting **feedback from Prof. Turculet**.
- **Quizzes** on material from the lectures, assigned readings, and practice problems will be available in Brightspace. Quizzes are to be **completed individually** and must be your own work. While quizzes can be completed **at your own pace**, it is recommended that you complete quizzes **in parallel with the lecture** schedule in order to stay on track with the course material.
- All quizzes are **due by Dec. 8, 2020** (last day of class); **no make-ups** will be offered.
- A total of **5 group projects** will be assigned throughout the semester. Projects will be carried out in **assigned groups of two**, which will be different for each project. You are expected to **meet on-line** with your project partner as needed to **discuss the project and brainstorm** solutions. While the work will be collaborative, each group member will **submit their own** completed final product. You may use your textbook, notes, problem sets, and course handouts as references for completion of the projects, but no other books or materials.
- A **final examination** will be distributed during the final exam period, which is scheduled for Dec. 10-20. The details of this will be announced in due course.

CHEM 3103 Lecture Schedule

Week 1 (Sept 9-11)	• Course Overview (Br) • Syllabus (Br) • Academic Integrity Pledge • Brief Introduction to Transition Metal Chemistry (Br) • **Start Topic 1**: Introduction to Coordination Complexes – Ligands & Structures **Reading: Ch 9 but omit Section 9.3.6; Ch 6–Section 6.6 only; Ch 4 (MF&T)** ○ What is a coordination complex? ○ Ligands
Week 2 (Sept 14-18)	• Continue Topic 1: Introduction to Coordination Complexes – Ligands & Structures ○ Ligands ○ Hard and soft acids and bases ○ Coordination numbers and structures ○ Isomerism
Week 3 (Sept 21-25)	• Finish Topic 1: Introduction to Coordination Complexes – Ligands & Structures ○ Symmetry and Point Groups
**** Project 1 released Sept 28; due Oct 11, by 11:59 pm ADT (Atlantic Daylight Time) ****	

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CHEM 3103 Lecture Schedule (continued)

Week 4 (Sept 28-Oct 2)	• **Start Topic 2**: Vibrational Spectroscopy **Reading: Ch 4–Section 4.4.2 only; Ch13–Section 13.8.1 only (MF&T)** ○ Introduction to Vibrational Spectroscopy ○ Representations of Point Groups ○ The Symmetry of Normal Vibrations
Week 5 (Oct 5-9)	• Finish Topic 2: Vibrational Spectroscopy ○ Stretching Mode Analysis ○ Using Vibrational Spectroscopy to Determine Structures • **Start Topic 3**: Bonding in Coordination Complexes **Reading: Ch 5; Ch 10–Sections 10.1-10.3.2, 10.3.4-10.3.5, 10.4.4-10.4.5, 10.5 (MF&T)** ○ Introduction to Bonding Models ○ Review of Molecular Orbital Theory for p-Block Molecules ○ Building Up MO Diagrams for Transition Metal Complexes
**** Project 2 released Oct 12; due Oct 25, by 11:59 pm ADT (Atlantic Daylight Time) ****	
Week 6 (Oct 12-16)	• Continue Topic 3: Bonding in Coordination Complexes ○ Building Up MO Diagrams for Transition Metal Complexes ○ Ligand Field Considerations
Week 7 (Oct 19-23)	• Finish Topic 3: Bonding in Coordination Complexes ○ Ligand Field Considerations ○ The Jahn-Teller Effect ○ Magnetic Susceptibility • **Start Topic 4**: Electronic Spectra of Coordination Complexes **Reading: Ch 11 (MF&T)** ○ Introduction to Electronic Spectra ○ Quantum Numbers of Multielectron Atoms ○ Energy Level Diagrams
**** Project 3 released Oct 26; due Nov 8, by 11:59 pm AST (Atlantic Standard Time) ****	
Week 8 (Oct 26-30)	• Continue Topic 4: Electronic Spectra of Coordination Complexes ○ Energy Level Diagrams ○ Determining Delta-o from Spectra ○ Electronic Spectra of Tetrahedral Complexes ○ Jahn-Teller Effects
Week 9 (Nov 2-6)	• Finish Topic 4: Electronic Spectra of Coordination Complexes ○ Charge-Transfer Spectra • **Start Topic 5**: Ligand Substitution Reactions **Reading: Ch 12–Sections 12.1-12.4.3, 12.4.5, 12.6-12.7 (MF&T)** ○ Introduction to Reaction Mechanisms ○ Rate Laws & Activation Parameters ○ Ligand Substitution Reactions in Octahedral Complexes
**** Project 4 released Nov 9; due Nov 22, by 11:59 pm AST (Atlantic Standard Time) ****	
Week 10 (Nov 9-13)	Fall Study Break
Week 11 (Nov 16-20)	• Finish Topic 5: Ligand Substitution Reactions ○ Ligand Substitution Reactions in Octahedral Complexes ○ Ligand Substitution Reactions in Square Planar Complexes
**** Project 5 released Nov 23; due Dec 6, by 11:59 pm AST (Atlantic Standard Time) ****	

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CHEM 3103 Lecture Schedule (continued)

Week 12 (Nov 23-27)	• **Start Topic 6**: Organometallic Chemistry **Reading: Ch 13–Sections 13.1-13.5.2, 13.6.1-13.6.3, 13.7-13.8 (MF&T)** ○ Introduction to Organometallic Chemistry ○ Electron-counting for Organometallic Complexes ○ Carbonyl Complexes ○ Hydride Complexes
Week 13 (Nov 30-Dec 4)	• Finish Topic 6: Organometallic Chemistry ○ Phosphine Complexes ○ Complexes of Organic Pi-Systems ○ Metal-Carbon Single, Double, and Triple Bonds
Week 14 (Dec 7-8) Note that Tues Dec. 8 is the last day of class and will follow a Monday schedule.	• **Start Topic 7**: Organometallic Reactions & Catalysis **Reading: Ch 14 (MF&T)** ○ Introduction to Organometallic Reactions & Catalysis ○ Fundamental Reactions of Organometallic Chemistry ○ Some Key Catalytic Processes
Final Exam Period Dec. 10-20	

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CHEM 3103 Laboratory Schedule

The lab component of this course will take the form of weekly quizzes / assignments supported by on-line group tutorials of approx. 1½ hours in length during the assigned lab periods (Wed and Fri 1:30 – 5:30 pm ADT). **We will use Collaborate Ultra for these tutorials. It can be accessed through the links embedded in the course Brightspace page.** Tutorial groups will be assigned (4–5 members per group). In each tutorial you will engage in a discussion with your group and a tutorial leader (teaching assistant or instructor). You will need to **prepare in advance** according to the schedule below (resource readings and an initial attempt at the weekly quiz / assignment) so you can actively participate in the discussions (10 points of your lab grade). The following week you will submit your final answers online. Submittals must be your own work, although you are encouraged to meet on-line with your group as needed during the week to brainstorm solutions.

**** On-line submittal deadlines: 1:30 pm on your lab day according to the schedule below. ****

Lab sections:	**CHEM 3103 B01 (Wednesdays)** **CHEM 3103 B03 (Fridays)**
Week 1 (Sept 9, 11)	On-line orientation 1:30 pm ADT • Getting acquainted • Summary of the semester • Open Q & A • Assignment: Submitting a pdf with an embedded picture
Week 2 (Sept 16, 18)	Module 1: vibrations of CrO_2Cl_2 • Submit Assignment: pdf with an embedded picture • Tutorial preparation: ○ Read and understand **intro to vibrations 1** (Brightspace: "resources for vibrations theory" folder) ○ Work through Module 1 Quiz / Assignment (vibrations of CrO_2Cl_2) and formulate discussion questions
Week 3 (Sept 23, 25)	Module 2: vibrations of $VOCl_3$ • Tutorial preparation: ○ Read and understand **intro to vibrations 2**. ○ Work through Module 2 Quiz / Assignment (vibrations of $VOCl_3$) and formulate discussion questions • On-line submittal of Module 1 Quiz / Assignment
Week 4 (Sept 30, Oct 2)	Module 3: geometry determination of $Ni(CO)_4$ using infrared and Raman C-O stretches • Tutorial preparation: ○ Read and understand **intro to vibrations 3**. ○ Work through Module 3 Quiz / Assignment (Geometry of $Ni(CO)_4$ using IR and Raman spectroscopy) and formulate discussion questions • On-line submittal of Module 2 Quiz / Assignment
Week 5 (Oct 7, 9)	Module 4: cis- and trans- $Mo(CO)_4L_2$: identification of isomers using ^{13}C / ^{31}P NMR and vibrational spectroscopy • Tutorial preparation: ○ Read and understand **molybdenum carbonyls: resources**. ○ Work through Module 4 Quiz / Assignment (cis- and trans- Mo compounds) and formulate discussion questions • On-line submittal of Module 3 Quiz / Assignment

On-line office hours Wednesdays and Fridays 12–1pm ADT (marc.whalen@dal.ca)

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Week 6 (Oct 14, 16)	Module 5: Geometry of $RuH_2(CO)(PPh_3)_3$ using ^1H / ^{31}P NMR and IR • Tutorial preparation: ○ Read and understand **A ruthenium compound with catalytic activity: resources**. ○ Work through Module 5 Quiz / Assignment (preparation of a Ruthenium catalyst: $RuH_2(CO)(PPh_3)_3$) and formulate discussion questions • On-line submittal of Module 4 Quiz / Assignment
Week 7 (Oct 21, 23)	Module 6: Werner-type Cr(III) octahedral complexes in aqueous solution – visible spectroscopy • Tutorial preparation: ○ Read and understand **Cr(III) complexes and the spectrochemical series: resources**. ○ Work through Module6 Quiz / Assignment (using visible spectroscopy to formulate a spectrochemical series) and formulate discussion questions ○ On-line submittal of Module 5 Quiz / Assignment
Week 8 (Oct 28, 30)	Module 7: Geometric variability of four-coordinate Ni(II) complexes (magnetic susceptibility, ^{31}P NMR, and UV/visible spectroscopy) • Tutorial preparation: ○ Read and understand **Four-coordinate Ni(II) complexes: resources**. ○ Work through Module 7 Quiz / Assignment (four-coordinate Ni(II) complexes) and formulate discussion questions • On-line submittal of Module 6 Quiz / Assignment
Week 9 (Nov 4, 6)	Module 8: Devising a procedure to safely prepare and characterize $Mn(CH_3)(CO)_5$. • Tutorial preparation: ○ Search for information regarding the preparation of $Mn(CH_3)(CO)_5$: journal articles, textbooks, web sites, etc. ○ Be prepared AS A GROUP to discuss a procedure – summarize what you have found and what else needs to be done • Discussion: preparing a presentation for the preparation and characterization of $Mn(CH_3)(CO)_5$ ○ Working out logistics for on-line presentations on week 11. • On-line submittal of Module 7 Quiz / Assignment
Week 10 (Nov 9-13)	No sessions (study week)
Week 11 (Nov 18, 20)	Group on-line presentations: Preparation and characterization of $Mn(CH_3)(CO)_5$ • 15-minute presentation using "screen share" feature • All group members must present content
Week 12 (Nov 25, 27)	Make up discussion sessions or quiz support

Laboratory Grading Scheme	**Points**
Quizzes / Assignments (8)	10 each (total 80)
Weekly on-line participation	10
Presentations (group grade) -- see Week 11 in the lab schedule	10
Presentations (peer evaluations)	10
Total	**110**

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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

Missed or Late Academic Requirements due to Student Absence
As per Senate decision instructors may not require medical notes of students who must miss an academic requirement**, including the final exam**, for courses offered during fall or winter 2020-21 (until April 30, 2021).
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-academic-requirements-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.
Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

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-student-conduct.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 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/services-support/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-to-get-help/ombudsperson.html

Safety

Research Lab Safety: https://www.dal.ca/content/dam/dalhousie/pdf/dept/safety/lab_policy_manual_2007.pdf

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