

**Faculty of Science Course Syllabus**  
**Department of Chemistry**  
**Advanced Main Group Chemistry**  
**CHEM 4101/5101**  
**Winter 2024**

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

**Instructor:** Dr. Saurabh S. Chitnis

**Lectures:** Mon, Wed, Fri 0935–1025 h; Location: LSC-Oceanography O3655 (or online)

**Office Hours:** Mon 1400–1500 h; Location: Chemistry 412 (or online, by e-mail appointment)

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**Course Description:** Following a brief overview of the fundamental aspects of preparation, structure and bonding for familiar systems, selected topics are examined in some detail. An emphasis is placed on novel structure and bonding arrangements in comparison with carbon chemistry.

**Course Prerequisites:** CHEM 3103 (grade of C– or better)

**Course Objectives/Learning Outcomes:**

- Derive molecular orbital (MO) diagrams for main group compounds and understand the relationship between MO manifold, molecular structure, and reactivity
- Understand and apply quantitative energy decomposition schemes to understand structure and bonding in s and p-block compounds
- Rationalize the structure and reactivity of multiply-bonded main group compounds
- Understand Lewis acid/base interactions quantitatively and the concept of Frustrated Lewis Pairs
- Understand the reactivity of molecular s-block compounds
- Understand the reactivity of amine-borane and phosphine-borane adducts as hydrogen sources and precursors to polymers

**Course Materials:** Electronic notes will be provided. Due to copyright issues, these must not be publicly shared. Resources pertinent to the presentation component of the assessment (see below) are available upon request.

**Course Assessment:**

| Component         | Weight | Date                               |
|-------------------|--------|------------------------------------|
| Midterm           | 30 %   | Feb 14, 2024                       |
| Presentation      | 20 %   | Last 2 weeks of class              |
| Final Examination | 50 %   | To be scheduled during exam period |

## Conversion of Numerical and Alphabet Grades:

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

### Course Policies:

*Class announcements:* Dr. Chitnis will post announcements on the lecture Brightspace sites when possible. However, anything stated or announced in lecture will be considered common knowledge.

*Meeting outside office hours:* Please note that outside of office hours, meeting with Dr. Chitnis is by appointment only. If you wish to set up a meeting, please email Dr. Chitnis, clearly indicating the reason you wish to meet as well as your availability.

*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/universitysecretariat/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 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 email within 24 h of the missed academic deadline or test, and
2. submit a Student Declaration of Absence (SDA) form on-line within 3 calendar days following the last day of absence.

The SDA can be used a maximum of two times. Note that 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 term test:* If you miss a term test for any reason, no make-up will be offered. Once the SDA form is submitted, points from the missed term test will be transferred to the final exam.
- *Missed presentation:* If you miss your presentation for any reason, no make-up will be offered. Once the SDA form is submitted, points from the missed presentation will be transferred to the final exam.
- *Missed final examination:* If you miss the final exam for reason, as per Dalhousie policy, the SDA form does not apply. You must contact Dr. Chitnis by email ([saurabh.chitnis@dal.ca](mailto:saurabh.chitnis@dal.ca)) within 24 h of the missed exam for further instructions. Appropriate documentation (e.g. medical certificate indicating dates and duration of illness and a description of the impact it had on your ability to fulfill academic requirements) must be submitted within 3 calendar days of the missed exam if you wish to write a make-up. If no appropriate notification and documentation is provided within the timeframe described above, no make-up will be allowed, and you will earn a mark of ‘0’ for the exam. Please note that if you are 30 minutes or more late to write a test or exam, it will be considered a missed test/exam.

**Topics covered:**

1. Electronic Structure
    - (a) Atomic Orbitals and Hybridization trends
    - (b) MO Diagrams
    - (c) Relativistic and Dispersion effects
    - (d) Formalisms
  2. Bonding
    - (a) Components of bonding: Energy Decomposition Analysis
    - (b) Bonding in diatomics
    - (c) Bonding in  $E_2$  and  $E_4$
    - (d) Heavy alkynes
    - (e) Heavy alkenes
    - (f) Molecular s-block hydrides
    - (g) TM chemistry of s-block elements
    - (h) Lewis Acid/Base interactions and Frustrated Lewis Pairs
  3. Reactivity
    - (a) Reactivity of heavy alkynes
    - (b) Reactivity of s-block compounds
    - (c) Reactivity of Frustrated Lewis Pairs
    - (d) Reactivity of NB/PB Adducts (hydrogenation)
    - (e) Reactivity of Nb/PB Adducts (dehydrocoupling)
  4. Independent Study Presentations: Topics assigned in class.
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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.

**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/universitysecretariat/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/campuslife/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/universitysecretariat/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](mailto:elders@dal.ca)).

Information: <https://www.dal.ca/campuslife/communities/indigenous.html>

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

<https://www.dal.ca/academics/importantdates.html>

**University Grading Practices:**

<https://www.dal.ca/dept/universitysecretariat/policies/academic/grading-practices-policy.html>

## Student Resources and Support

### Advising:

- **General Advising:**  
<https://www.dal.ca/campuslife/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/campuslife/communities/indigenous.html>
- **Black Students Advising Centre:**  
<https://www.dal.ca/campuslife/communities/black-student-advising.html>
- **International Centre:**  
<https://www.dal.ca/campuslife/international-centre/current-students.html>

### Academic supports:

- **Library:**  
<https://libraries.dal.ca/>
- **Writing Centre:**  
<https://www.dal.ca/campuslife/academic-support/writing-and-study-skills.html>
- **Studying for Success:**  
<https://www.dal.ca/campuslife/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/campuslife/health-and-wellness/services-support/student-health-and-wellness.html>
- **Student Advocacy:**  
<https://dsu.ca/dsas>
- **Ombudsperson:**  
<https://www.dal.ca/campuslife/safety-respect/student-rights-and-responsibilities/where-to-get-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-and-updates.html>