

SC/CHEM 6030 (3 credits) Advanced Main Group Chemistry

Term

Fall 2018

Time and Location

tbd

Prerequisite

BSc (or equivalent) in Chemistry

Course Instructors

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Course Description

The common thread of the course are the structure, bonding, and reactivity of the (organo)main group, or p-block, elements (groups 1, 2, 13, 14, 15, 16, 17, 18), particularly with a view toward non-classical bonding environments (i.e.; low-valent and hypervalent bonding). This will include establishing trends within the periodic table using fundamental acid-base concepts, steric and electronic driving forces, as well as applying MO theory. These comprehensive fundamental topics will then lead into the 'renaissance of main group chemistry' relating to state-of-the-art research with regard to materials and catalysis applications of main group compounds.

The following topics will be covered over the semester:

- **Organometallic chemistry of Alkali Metals** (Li, Na, K; structure, bonding, reactivity, applications)
- **Organometallic chemistry of Alkali Earth Metals** (Be, Mg; structure, bonding, reactivity, applications)
- **Organometallic Compounds of Group 13** (B, Al, Ga, In, Tl; structure, bonding, reactivity, applications)
 - BN compounds, BC compounds & heterocycles, B subhalogenides
 - Organoaluminum compounds, Lewis Base adducts of AlR_3 compounds, subvalent Al compounds.
 - Organogallium, -indium, and -thallium compounds
- Organometallic Compounds of Group 14** (Si, Ge, Sn, Pb; structure, bonding, reactivity, applications)
 - Organosilicon compounds: (organo)silanes, chlorosilanes, silicones, silylenes, molecules with $Si=E$ and $Si\equiv E$ π -bonds, hypervalent Si compounds
 - Organogermanium, -tin, and -lead compounds

Chemistry of the Group 15 Elements (mostly N, P; structure, bonding, reactivity, applications)

Nitrogen: structure and bonding of selected N-oxides

Organophosphorus compounds: P(V) compounds (structure, bonding, reactivity), P(III) Compounds: diphosphenes, phosphalkenes, iminophosphanes, P-containing ring systems (phosphabenzene, phosphole)

Chemistry of the Group 16 Elements (mostly S; structure, bonding, reactivity, applications)

Chemistry of the Group 17 Elements (F, Cl, Br, I; structure, bonding, reactivity, applications)

Interhalogen compounds, main group element fluorides (including Group 18)

“The Renaissance of Main Group Chemistry”

Modern aspects of main group chemistry including catalysis and materials chemistry

Purpose and Objectives of the Course

The course is designed for graduate students specializing in synthetic inorganic, organic, and materials chemistry, but is also expected to be of interest to course-based Masters students. This course is expected to be of high utility to graduate students arriving from other institutions where rigorous training on the non-classical structure and bonding of main group elements was not available, by providing a foundational basis for the fundamental concepts critical to the completion of their graduate degrees.

Textbooks

Much of the course will be based on the following **highly recommended** text books:

Elschenbroich,

Organometallics, 3rd, Completely Revised and Extended Edition; ISBN: 978-3-527-80516-7

Huheey, Keiter, Keiter,

Inorganic Chemistry: Principles of Structure and Reactivity; ISBN: 978-0-060-42995-9

Additional aspects are covered in the following **recommended** textbooks:

Massey,

Main Group Chemistry, 2nd Edition; ISBN: 978-0-471-49039-5

Greenwood, Earnshaw,

Chemistry of the Elements; ISBN: 978-0-7506-3365-9

Akiba,

Organo Main Group Chemistry; ISBN: 978-1-118-02588-8

Erker, Stephan,

Frustrated Lewis Pairs I

(available online here: <https://link.springer.com/book/10.1007%2F978-3-642-36697-0>)

Erker, Stephan,

Frustrated Lewis Pairs II

(available online here: <https://link.springer.com/book/10.1007%2F978-3-642-37759-4>)

Baumgartner, Jaekle,

Main Group Strategies towards Functional Hybrid Materials; ISBN: 978-1-119-23595-8

(available online here: <https://onlinelibrary.wiley.com/doi/book/10.1002/9781119235941>)

Organization of the Course

Much of the lectures will be delivered by the Course Instructors but will require active participation of the students in the form of discussions as well as a presentation. Supplementary slides with pertinent figures will be posted ahead of the class on Moodle. It is the student's responsibility to sign up for an account. See <https://moodle10.yorku.ca/moodle/> for details.

Evaluation

The level of proficiency in the material will be assessed through the elements listed below. The final grade for the course will be based on the following items weighted as indicated.

Assignments (6): 30%

Presentation: 25%

Class Participation: 10%

Final Exam (Research Proposal): 35%

Six assignments (5% each) will involve course-specific problems. The problem-set based assignments will reinforce the topics and concepts that align with the progress in class. Students will be expected to answer using concise, scientific writing.

The presentation (25%) will involve a 20 minute in-class lecture by each student on a topic that is arms-length to their respective thesis research topic. The topic can be selected from a list or chosen by the student (with approval from the instructor). Students will examine the peer-reviewed literature and extract the appropriate information to be included as it relates to the course content. The presentation will form the basis for the final exam component.

The final exam (35%) will be in the form of a research proposal that pertains to the contents of the in-class presentation. The 5-page proposal is expected to follow NSERC rules for a Discovery Grant proposal using concise, effective scientific writing.

Grading Scheme, Assignment Submissions, Lateness Penalties, Academic Integrity

The grading system for the course follows the outline from the Faculty of Graduate Studies at York (e.g., A+ = 90-100%, A = 85-89%, A- = 80-84% B+ = 75-79%, B = 70-74%, C = 60-69%, F = 0-59%). Evaluation components will bear either a letter grade designation or a corresponding number grade.

(For a full description of York grading system see the Faculty of Graduate Studies

<http://gradstudies.yorku.ca/current-students/regulations/courses-grading/>)

Proper academic performance depends on students doing their work not only well, but on time. Accordingly, the assignments must be received on the due date specified for the assignment, which are to be handed at class on the due date. Assignments should NOT be deposited in the Course Instructor's mailbox. **Assignments received later than the specified time on the due date will result in no credit (0%).** Exceptions to the lateness penalty will be entertained by the Course Instructor only when supported by written documentation (see above). The grading scheme will be adjusted accordingly.

Important Course Information

All students are expected to familiarize themselves with the following information, available on the Senate Committee on Academic Standards, Curriculum & Pedagogy webpage (see Reports, Initiatives, Documents) - <http://secretariat-policies.info.yorku.ca>

- Senate Policy on Academic Honesty and the Academic Integrity Website
- Ethics Review Process for research involving human participants
- Course requirement accommodation for students with disabilities, including physical, medical, systemic, learning and psychiatric disabilities
- Student Conduct Standards
- Religious Observance Accommodation