Department of Chemistry Course Syllabus

Chem 355S: Introduction to Polymer and Materials Chemistry, Winter 2023

I. CONTACTS

INSTRUCTORS

Eugenia Kumacheva

Email: eugenia.kumacheva@utoronto.ca, Office: Room 627

Online student lecture day and times: Thursdays 5-7 pm.

Eugenia Kumacheva is a Distinguished University Professor of Chemistry and Canada Research Chair in Advanced Polymer Materials. Her research interests are in the field of Soft Matter, i.e., polymers, colloids, liquid crystals and biological soft matter. She held scholarship positions in Harvard, Oxford, and Cambridge University, The Universities of Strasburg and Bayreuth, Moscow State University and the University of Information Technologies, Mechanics and Optics (Russia). She in an author of a book "Microfluidic Reactors for Polymer Particles".

Geoffrey Ozin

Email: g.ozin@utoronto.ca, Office: Room 326

Online student lecture day and times: Thursdays, 5-7 pm.

Geoffrey A. Ozin is a Distinguished University Professor and Government of Canada Research Chair in Materials Chemistry and Nanochemistry. He currently spearheads the Solar Fuels Team www.solarfuels.utoronto.ca at the University of Toronto St. George Campus. He has held positions as Honorary Professor at The Royal Institution of Great Britain and University College London, External Adviser for the London Centre for Nanotechnology, Alexander von Humboldt Senior Scientist at the Max Planck Institute for Surface and Colloid Science and the Center for Functional Nanostructures at the Karlsruhe Institute of Technology, and Global Chair at Bath University. He is the author of five books: Cryochemistry (Wiley 1986); Nanochemistry: A Chemical Approach to Nanomaterials (RSC 2005, 2009); Concepts of Nanochemistry (Wiley-VCH 2009), The Story of CO2: Big Ideas for a Small Molecule (University Toronto Press 2021), Energy Materials Discovery for a Sustainable Future (RSC 2022), The Story of CH4: Five Atoms that Changed our World (RSC 2023).

II. TEACHING ASSISTANTS

Jessica Ye, Polymer Materials, Email: jessie.ye@mail.utoronto.ca

Jessica is a first-year PhD student in the Ozin and Sain labs. Her projects focus on the photo-reformation of industrial polymers and the utilizations of carbon in photocatalytic processes.

Andrew Wang, Inorganic Materials, Email: ac.wang@mail.utoronto.ca

Andrew is a 3rd year PhD student cross-supervised between the Ozin and Aspuru-Guzik groups. His research focuses on findings ways to use solar energy for making fuels and feedstocks through gas phase heterogeneous CO_2 photocatalysis in the solid state.

II COURSE OVERVIEW

COURSE DESCRIPTION

An online course on polymer and materials chemistry designed as a follow-up to CHM 247 (Introductory Organic Chemistry II) and CHM 238 (Introduction to Inorganic Chemistry).

Polymer Section – Part I

Polymers are widely employed both as commodity materials and for specialty applications. Commodity materials include plastics such as polyethylene, polypropylene, and polystyrene, elastomers such as polyisoprene, and coatings constituents' such as acrylic polymer nanoparticles. Polymers designed for specialty applications are sometimes referred to as "advanced polymer materials" and find application in diverse areas such as photoresists for microelectronic device fabrication, compatibilizers for polymer blends, and colloidal species such as block copolymer micelles and microgels for drug delivery and other biomedical applications. In this series lectures, students will be introduced to concepts in polymer synthesis, structure, and architecture, polymer solutions and melts, and polymer in the solid state.

Inorganic Materials Section – Part II

Traditional metals and semiconductors are normally associated with solid state materials like Na, Ag, Pt and Si, GaAs, CdSe. Their structure–property relations are described within the framework of Block-Wilson electronic band theory and Schottky-Frenkel defect theory. This section of the course is about non-traditional metals and semiconductors. The building units are not atoms of the periodic table organized in an extended periodic 1D, 2D or 3D network structure. Instead, they are comprised of regular arrangements of organic and inorganic molecule, coordination and organometallic compounds, cluster, and polymer building blocks, which can function as novel kinds of metals and semiconductors and even superconductors, with myriad applications in advanced materials and biomedical science.

TOPICS COVERED

Polymer Section

The goal of this section is to introduce students into the world of polymer materials. The topics included in this section include the main classes of polymerization reactions and processes, polymer solubility concepts and thermomechanical properties of polymers. Several applications of polymer applications in drug delivery, optical data storage, shape memory and self-healing will be demonstrated.

Inorganic Materials Section

The goal of this section is to provide a cohesive introduction into the world of non-traditional metals and semiconductors. The topics covered will include the synthesis of various representative members of this class of non-traditional materials, relations between their structure and bonding, properties and function will be examined, and their utility in application areas like solar cells and batteries, light emitting diodes and transistors, smart fabrics, sensors, and digital displays will be explored.

STUDENT LEARNING OUTCOMES

At the end of the course, successful students will be able to apply chemical and physical concepts and principles, laws and equations that underpin molecular chemistry and traditional solid-state metal and semiconductor chemistry to more advanced aspects of polymers and materials.

Students will be able to understand how the synthesis, composition, and structure of different classes of these polymer and materials relate to their chemical and physical properties, and how these properties provide different kinds of functionality.

With these ideas, knowledge and connections students will be able to use the relations between synthesis, structure, property and function to envision wide-ranging applications of polymers and materials in the world of high technology products and processes.

PREREQUISITE COURSES

This course assumes you have a basic understanding of organic and inorganic chemistry, including topics covered by the prerequisites for the course (CHM 238Y and CHM 247H/CHM 249H).

REQUIRED TEXTS

Polymer Section. Painter, P.C.; Coleman, M. M., Fundamentals of Polymer Science (1998 and 2008) and Lecture Notes.

Inorganic Materials Section. L. Smart and E. Moore, Solid State Chemistry, An Introduction, Chapman and Hall, London, Fifth Edition and Lecture Notes.

III HOW THE COURSE IS ORGANIZED

This course involves 2-hour weekly classes, scheduled Thursdays, 5-7 pm throughout the spring semester. Lectures will be given online. Term tests and the final exam will be given in-person. Over the course of each week throughout the term, you are expected to attend the classes, read the PowerPoint class notes and relevant parts of the required texts, supplement this reading with useful material in the recommended texts, participate in office hour tutorial sessions, scheduled Thursdays 3-4 pm and take term tests and final exam according to the due dates.

The purpose of the tutorials is to discuss any aspect of the course that needs elaboration, brainstorm food for thought questions presented in the lectures, clarify expectations on the level of understanding of relevant background material covered in prerequisite courses, consider how the course material will relate to more advanced courses at the fourth and graduate level, and encourage lively discussion about the past, present, and future of the field of polymer and materials chemistry.

COURSE SCHEDULE & RELEVANT SESSIONAL DATES:

DATES	LECTURES 5-7 pm
January 10th	Meet n' Greet with EK and GAO
January 12th	Lecture 1-2_EK
January 19th	Lecture 3-4_EK
January 26th	Lecture 5-6_EK
February 2nd	Lecture 7-8_EK
February 9th	Lecture 9-10_EK
February 16th	Term test 1
February 20-24th	Reading week, no classes
March 2nd	Lecture 11-12_GAO
March 9th	Lecture 13-14_GAO
March 16th	Lecture 15-16_GAO
March 23rd	Lecture 17-18_GAO
March 30th	Term test 2
April 6th	Lecture 19-20_GAO
April 11-28th	Final Assessment Period

Eugenia Kumacheva's lectures will be conducted over Zoom with Video recordings. Lecture notes in PDF format and video recordings will appear on Quercus.

Geoff Ozin's lectures will be conducted over Zoom with Video recordings. Lecture notes in PDF format and video recordings will appear on Quercus.

LECTURES

Eugenia Kumacheva and Geoff Ozin: Thursdays 5-7 pm, on Zoom

Join Zoom Meeting

[redacted]

[redacted]

OFFICE HOURS

Eugenia Kumacheva and Geoff Ozin: Thursdays 3-4 pm, on Zoom

Join Zoom Meeting

[redacted]

Passcode: [redacted]

TUTORIALS

Wednesday 12 - 1 PM, in-person.

Room 158

NOTE: Depending on health and safety guidelines, tutorials will be given in person in LM Room 158, however please follow the announcements.

IV EVALUATION/GRADING SCHEME

In class 1 hour mid-term test 1	25%
In class 1 hour mid-term test 2	25%
Final Exam (2 hours)	
April 11-29th Final Assessment Period	50%

Flexibility will be given in the grading, with the best mid-term assignment in the polymer and materials sections worth 30% and the worse 20%.

Note: if an unexpected health and safety situation arises or a technical issue occurs with a university system (e.g., Quercus services, network outage) that affects availability or functionality, it may be necessary to revise the in-person testing, timing or weighting of the assessments.

V COURSE POLICIES

- Students are highly encouraged to attend a pre-class "Meet n' Greet" scheduled for January 10th, 5-7 PM. We will go over course content, etiquette and expectations.

  Join Zoom Meeting

  [redacted]

  Getting in touch: please contact the course instructor and teaching assistant with any questions about the course by email, Eugenia Kumacheva: eugenia. kumacheva@utoronto.ca; Geoffrey Ozin: g.ozin@utoronto.ca; TA's: Jessica Ye (polymer part) jessie.ye@mail.utoronto.ca, Andrew Wang, email: ac.wang@mail.utoronto.ca

- The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. We have the highest expectations from you all to act in a respectful manner towards your peers and colleagues.

- This course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session. Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation and are protected by copyright. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

- Students are responsible for informing the instructor and TA about any expected absences. In case of emergency, it is vital to notify us as soon as possible so accommodations can be made.

VI TECHNOLOGY REQUIREMENTS

Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/

This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses, damaged hard drives, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are not acceptable grounds for a deadline extension.

VII INSTITUTIONAL POLICIES AND SUPPORT

ACADEMIC INTEGRITY

On Academic Integrity:

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

On quizzes and term tests:

1. Using or possessing unauthorized aids. Please note that the use of websites (such as Chegg.com or the course discussion board) to post quiz/term test questions or to post/access answers to questions is an academic offence under the University of Toronto's Code of Behaviour on Academic Matters. Alleged instances of this nature are forwarded to the Faculty of Arts & Science Student Academic Integrity office.
2. Looking at someone else's answers or collaborating/discussing answers during a quiz or term test.
3. Misrepresenting your identity.

In general academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see www.academicintegrity.utoronto.ca/).

Plagiarism Detection

"Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation web site (https://uoft.me/pdt-faq)".

COPYRIGHT

If a student wishes to copy or reproduce class presentations, course notes or other similar materials provided by instructors, he or she must obtain the instructor's written consent beforehand. Otherwise, all such reproduction is an infringement of copyright and is absolutely prohibited.

ACCESSIBILITY NEEDS

Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact Accessibility Services as soon as possible.

ACCOMMODATIONS FOR RELIGIOUS OBSERVANCES

Following the University's policies, reasonable accommodations will be made for students who observe religious holy days that coincide with the due date/time of an assignment, tutorial, class or laboratory session. Students must inform the instructor **before** the session/assignment date to arrange accommodations.

ADDITIONAL SERVICES and SUPPORT

The following are some important links to help you with academic and/or technical service and support

- General student services and resources at Student Life
- Full library service through University of Toronto Libraries
- Resources on conducting online research through University Libraries Research
- Resources on academic support from the Academic Success Centre
- Learner support at the Writing Centre
- Information for Technical Support/Quercus Support

ACKNOWLEDGMENT OF TRADITIONAL LANDS

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca and, most recently, the Mississauga's of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.