Western Science

Department of Mathematics

AM4615F/AM9563A
Introduction to Applied Computer Algebra

1 Course Information:

Title: Applied Computer Algebra

Term: Fall 2023

Times and Location:

Tuesdays 12:30-2:30: Middlesex College (MC) 204
Thursdays 12:30-1:30 : Health Sciences Building (HSB) 13

Prerequisites:

Applied Mathematics 2814F/G (Numerical Analysis)

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

2 Instructor Information

Instructor	Email
Prof. Taylor Brysiewicz	tbrysiew@uwo.ca
Office	Office Hours
Middlesex College 114	Tuesdays 3:00pm-4:00pm or appt

Graduate Assistant	Email
TBD	TBD

Office hours will be offered as in-person, or optionally via zoom by request.

3 Course Syllabus, Schedule, Delivery Mode

Course Description:

This course will survey a handful of topics in computer algebra, ranging from representing/manipulating algebraic objects on a computer, to complex algorithms and open questions at the forefront of mathematical research. By the end of this course, students will be experienced users in at least one computer algebra system and will have a grasp on the breadth of modern mathematical software. The computational tools discussed in this class will involve linear algebra, polyhedral geometry, and computational algebraic geometry. Problems will be motivated by applications.

Learning Outcomes: Learning outcomes include the abilities to

- Articulate several ways in which symbolic and numerical computations differ
- Write functions proficiently in at least one computer algebra system
- Identify the appropriate software to solve several problems (i.e. software systems, packages, or functions which have the functionality required)
- Demonstrate knowledge of several standard algorithms in computer algebra through explaining the basic

steps, executing those steps, and justifying why they work
• Use Gröbner bases efficiently

Schedule: The pace of the class will be adaptive. We will cover computational and applied aspects of computer algebra topics according to the **tentative** schedule below

Week of	Topic
Sep 7 & 12	Introduction to Computer Algebra
Sep 14	Introduction to Computer Algebra Systems
Sep 19	Representing numbers, basic algorithms, Euclidean algorithm
Oct 3	Polyhedral geometry
Oct 10	Univariate polynomials
Oct 17	Polynomial systems and their solutions (ideals and varieties)
Oct 24	Term orders and Buchberger's algorithm
Nov 7	Gröbner bases
Nov 14	Polynomial systems in applications
Nov 21	Numerical Algebraic Geometry
Nov 28	More Numerical Algebraic Geometry
Dec 5	Open questions

Contingency Plan:

Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all of the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will not change. Any assessments affected will be conducted online as determined by the course instructor.

4 Course Materials

Students are responsible for checking the course OWL site (http://owl.uwo.ca) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. All course material will be posted to OWL: http://owl.uwo.ca. If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Recommended Software:

• Maple (used in class - not free for personal use)
• julia (free)
• Macaulay2 (free)

Textbooks:

No textbook is required. Resources include the lectures, possible course notes distributed on the course OWL site, and the documentation of the software used. For further reading, consider the following:
• Cox, Little, O'Shea, *Ideals, Varieties, and Algorithms*
• von zur Gathen, Gerhard, *Modern Computer Algebra*
• Joswig and Theobald, *Polyhedral and Algebraic Methods in Computational Geometry*
• Sommese and Wampler, *The Numerical Solution of Systems of Polynomials Arising in Engineering and Science*

Technical Requirements:

Access to a computer with the recommended software (or other similar software, like `Macaulay2`) installed. (optional) For the projects, students may consider learning how to use `Latex`

5 Methods of Evaluation

Evaluation:

Assignments (#:4)	40%	(Due: Sept 26. Oct 17. Nov 7. Nov 23.)
Project Update 1	5%	(Due: Oct 3.)
Project Update 2	10%	(Due: Nov 14.)
Project	15%	(Due: Nov 30.)
Final Exam	30%	TBD

Assignments:

Will be posted to OWL. They will be worked through partially in the Thursday lab sessions. They will be turned in by hand in class on the due dates set above.

Project:

Each student will work in a team to write a 7 page paper about a topic in applied computer algebra. The topics and groups will be assigned, however, preferences on group and topic will be taken into account. **Project Update 1** will consist of establishing the basic background for your project and outlining your paper. **Project Update 2** will consist of a progress report on your project, i.e. a first draft with at most minor details missing. The project updates and the final project will be turned in via email as a .pdf attachment along with any accompanying code. The passing grade for this project is 60%. To pass the course, you must receive a passing grade on the Project.

Final Exam:

The final exam will be from TBD to TBD in room TBD. You are allowed to use the computer algebra software on the computers, or optionally, bring your own computer. The exam will test your ability to use computer algebra software to solve problems in theory and applications.

Makeup Exam Date: TBD

Evaluation of Graduate Students: Graduate students are evaluated differently than undergraduate students in this course:

- Assignments: Graduate students will answer additional questions indicated by [ForGraduateStudents]
- Projects: The assigned topics will be chosen at the graduate level
- Final Exam: Graduate students will answer additional questions indicated by [ForGraduateStudents]

6 Student Absences

If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

Assessments worth less than 10% of the overall course grade For work totaling less than 10% of the overall course grade, an extension of one week will be given.

Assessments worth more than 10% of the overall course grade

For work totalling 10% or more of the final course grade, you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University's medical illness policy (click here) and review the Student Medical Certificate (click here). In the event that the links do not work, type either

- https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration.pdf (for policy)
- https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf (for certificate)

into your browser.

Missed assignments due to excused absences will be resolved via assignment-extensions.

Absences from Final Examination

If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a makeup Final Exam). You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

Note: missed work can only be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is not sufficient on its own.

7 Accommodation and Accessibility

Religious Accommodation

When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult the University's list of recognized religious holidays (click here), which is updated annually. Alternatively, you may wish to enter

- https://multiculturalcalendar.com/ecal/index.php?s=c-univwo

directly into your browser.

Accommodation Policies

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. Students can consult the policy on Academic Accommodation for Students with Disabilities (click here). Alternatively, type

- www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf

into a browser.

8 Academic Policies

The website for Registrarial Services is http://www.registrar.uwo.ca. In accordance with policy, https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner. Any mathematical software on your computer or a computer in the lab is permitted on the final exam.

Scholastic offences:

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

TURNITIN:

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting

plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Remote Proctoring: In the event of a health lock-down, tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at https://remoteproctoring.uwo.ca

Use of Generative AI: The use of generative AI technology like chatGPT is prohibited for homework assignments. Using this technology is not prohibited for the project portion of the course, however, plagiarizing the responses given is strictly prohibited. Use of such technology is to be submitted in an auxiliary file containing all relevant prompts and responses.

9 Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.uwo.ca/sci/counselling/ (click here).

Students who are in emotional/mental distress should refer to Mental Health@Western by visiting their website https://uwo.ca/health/ (click here) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will information about support services for survivors, including emergency contacts is available (click here). If you cannot access the link you can type

- https://www.uwo.ca/health/student_support/survivor_support/get-help.html

into your browser. To connect with a case manager or set up an appointment, please email support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education (click here) if you have any questions regarding accommodations. If the link provided does nto work, type

- http://academicsupport.uwo.ca/accessible_education/index.html

into your browser.

Learning-skills counsellors at the Student Development Centre (click here) are ready to help you improve your learning skills (alternatively, type https://learning.uwo.ca into your browser). They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Additional student-run support services are offered by the USC, https://westernusc.ca/services/ (click here).