

# CAS 738: Algebraic Methods in Software Engineering and Computer Science

## —Course outline (2020 - 2021)—

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**Office hour:** Thursday from 1:00 PM to 2:00 PM

### Course Description

The course covers a variety of software development issues, and testifies to the versatility of algebraic methods when used as conceptual tools in the software development process. The topics include algebraic approaches to software requirements, design, programme verification, testing, and security. Several algebraic structures (e.g. relation algebra, Kleene algebra, product family algebra) are introduced and used to discuss software related issues.

### Course Objective and the Method of Presentation of the Course Material

The aim of this course is to convey to graduate students the fact that concepts of abstract algebra in general and relation, cylindric, and Kleene algebras in particular can be efficiently used in Software Engineering and Computer Science modeling and applications. Before tackling applications, students need to be made familiar with the necessary model theory and universal algebra theory and with the theories of the considered algebras.

Some familiarity with elementary aspects of first-order logic and set theory is assumed, though many of the definitions are given in class. The course aims to be generally self-contained.

About two-thirds of the material is presented through lectures, and the rest through in-class presentations given by the students.

### Content

- Recall of Basic Mathematical Concepts: Sets, Relations, Formal logics, proposition logic, and first-order predicate calculus
- Structures and theories, models, validity of a formula, constructions of algebras
- Basic facts about binary relations, relation algebras and their representations, examples of relation algebras, relativised and weak representations of relation algebras, bases for atomic relation algebras, relational techniques in requirements analysis, architecture design, and testing
- Product family algebra (PFA), applications of PFA in software feature modeling, an aspect-oriented language based on PFA
- Algebraic techniques in information security: Covert channels, Network segmentation and Software Defined networks, and Cryptographic Protocols
- Algebraic techniques in data analytics and domain modeling
- Measurement in Software Engineering: The Representational Theory of Measurement, Measurement and Models, Measurement Scales and Scale Types, Combination Rules of Measures, Scale Types of Counting, Money, and Time.

## Course Information on Web

The latest version of the course outline, the slides used in class, the material related to the course project, and announcements at the course website on **Avenue to Learn** (<https://avenue.c11mcmaster.ca>). It is the student's responsibility to be aware of the information on the course website, and to check regularly for announcements.

## Method of Evaluation

There will be two assignments. Over the course of the term and depending on the size of the class, each student will present up to two papers in class and will prepare reviews of up to two papers. The reports of the assignments and the reviews will be due by 12:00 PM on the due date. Assignments and reports are to be submitted to the instructor on his email [khedri@mcmaster.ca](mailto:khedri@mcmaster.ca). Late assignments or review will be marked with a late penalty of 20% per day. Graded reports will be returned to your email address. **All reports may not be marked in detail.** No responsibility for loss of assignments can be assumed by the instructor; Please a copy of all submitted work.

The marking scheme is as follows:

- |   |                                |
|---|--------------------------------|
| i. Attendance and class participation 10% | iii. Paper Presentations 30%   |
| ii. Paper reviews 20%                     | iv. Assignments 40% (20% each) |

## References

1. Rudolf Lidl and Günter Pilz. *Applied Abstract Algebra*. Springer, 1998.
2. Jonathan D. H. Smith and Anna B. Romanowska. *Post-Modern Algebra*. Wiley-Interscience Series in Pure and Applied Mathematics, Wiley Inter-Science, 1999.
3. G. Schmidt and T. Ströhlein. *Relations and Graphs*. EATCS Monographs in Computer Science, Springer-Verlag, 1993.
4. Robin Hirsch and Ian Hodkinson. *Relation Algebras by Games*. Elsevier, 2002.
5. David Marker. *Model Theory: An Introduction*. Graduate Texts in Mathematics, Springer, 2002.

## Policy Statements

I am eager to support you and help you to have a good learning experience. I would appreciate your suggestions on how the course can be improved.

- Significant study and reading outside of class is required.
- Regular class attendance is expected. If you do not attend regularly, it will be reflected in your attendance and class participation grade. If you cannot attend the class or cannot participate in the class discussions, please discuss the issue with me as soon as possible.
- You are strongly urged to ask questions during class.
- You may want to discuss the exercises with your fellow students. If you do that, you must include a list of all those with whom you discussed the exercise in your final submission and describe what information you received. It is part of your professional responsibility to give credit to all who have contributed to your product.
- Your final submission must be your own work. If it is discovered that you have not written your own solutions, or that you have consulted with people not mentioned in your submission, it will be considered as academic dishonesty.
- The instructor reserves the right to increase by a fixed number of points the final scores.
- The instructor reserves the right to assign extra grades for extra work done by willing students. However, the work subject to extra grades should be advertised during the lectures.
- No responsibility for loss of deliverables can be assumed by the instructor. **Keep copies of your own assignment reports, your review reports, and your email exchanges with the instructor.**
- The lectures will not necessary follow the order in which the topics are presented in the detailed course outline. Regular class attendance is required.

## Official Statements

### ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

### AUTHENTICITY / PLAGIARISM DETECTION

*Some courses may* use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity).

### COURSES WITH AN ON-LINE ELEMENT

*Some courses may* use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

### ONLINE PROCTORING

*Some courses may* use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

## CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

## ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

## REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

## ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

## COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

## EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.