McMaster University | SCIENCE Department of Mathematics & Statistics

We recognize and acknowledge that McMaster University meets and learns on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the "Dish With One Spoon" wampum, an agreement amongst all allied Nations to peaceably share and care for the resources around the Great Lakes.

MATH 2R03 – Theory of Linear Algebra

2022 Winter Term

Instructor: Adam Van Tuyl | **E-mail:** vantuyl@math.mcmaster.ca | **Office:** HH-419

Office Hours: TBA | **Webpage:** https://ms.mcmaster.ca/~vantuyl/

Class Time and Location:

Lectures: **Class C01:** Tuesday, Thursday, Friday 2:30 - 3:20 PM in BSB B135

Tutorials: **T01:** Friday 3:30pm – 4:20pm in ABB 271

T02: Wednesday 3:30 – 4:20pm in PGCLL M12

Course Website

- Consult the course webpage. Please check it regularly.

The best way to contact me is via email.

Course Description

Abstract vector spaces. Linear transformations. Inner product spaces. Spectral theorems. Orthogonal bases, other topics.

Prerequisite(s): One of MATH 1AA3, 1LT3, 1NN3, 1XX3, 1ZB3, ARTSSCI 1D06 A/B, ISCI 1A24 A/B; and one of MATH 1B03, 1ZC3, 1ZZ5

Course and Learning Objectives

In this course we will focus on the theoretical underpinnings of linear algebra, and in particular, we will emphasize the proofs of linear algebra. The main objectives of this course are:

- to learn topics in linear algebra such as linear transformations, inner product spaces, invariant subspaces, and the spectral theorems.
- to learn and improve your proof writing skills.

Materials & Fees

Required Textbook: *Linear Algebra Done Right* by Sheldon Axler

(The textbook can download for free from the McMaster Library.)

Comparison to Math 2LA3

This course's primary concern will be the theory of linear algebra. Math 2LA3 focuses more on the applications of linear algebra and is offered in both terms. At least one (you can take both) of Math 2LA3 or Math 2R03 is required for all Honours Math and Stats programmes. Math 2R03 is required for Honours Math and Stats with a Mathematics subplan. Either linear algebra course is an allowable prerequisite for most third year Math and Stats courses. For Math 3A03, Math 3B03, Math 3GR3, Math 3F03, Math 3FF3 and Math 3QC3, the requirement is Math 2R03 or a grade of at least of B+ in Math 2LA3 (this change will occur in 2022-23).

Course Schedule

By the end of the semester, we will cover Chapters 1-6 and parts of Chapters 7 and 8 of the class textbook. We will spend roughly 1-1.5 weeks per chapter. A complete schedule will be made available on the course webpage.

Course Delivery

Until at least February 7, 2022, this course will be delivered online. Until Feb. 7, the course will be delivered using both asynchronous and synchronous components. The asynchronous component consists of video lectures of the course material (posted on Avenue and YouTube). For the synchronous component, we will use the scheduled class time as follows:

- First lecture of the week. (Tuesday) The scheduled class time will be used to review the past week's material, introduce the current week's material, and answer any questions.
- Second and third lecture of the week. (Tuesday and Thursday) The instructor will be online to answer questions. However, the time can be used by you to watch video lectures and do homework.

After February 7, the current plan is to return to in-person lectures.

The tutorials will allow you to interact with the course TA in order to learn more about the material. They will be offered online until February 7, and in-person after this date (if we return).

Course Overview and Assessment

Homework (9 Assignments)

There will be nine short homework assignments, given weekly. The lowest mark of the nine homework assignments will be dropped. A homework assignment will be given out weekly and will be due the following Saturday at 11:59PM. Assignments will be submitted via Crowdmark. You will receive an email link to your McMaster address to upload your assignment. In general, there are two types of problems: (a) computational problems and (b) proof problems.

(a) Computational Problems: Computation problems are exercises that review the concepts and definitions introduced in the section. These exercises will be marked out of 2 points as follows:

Points	Description
2 pts	Near perfect or perfect solution. A near perfect solution is a solution that is correct up to the final stage with possible mistake or sign error at the last step
1 pt	The solution shows some of the needed ideas, but fails to have the final solution
0 pts	Little or no progress is made toward the solution.

(b) Proof Problems: These exercises usually involve proving statements using the results and concepts from the corresponding section. Exercises will also be graded on how the proof has been written. These problems will be graded out of 5 points as follows:

Points	Description
5 pts	A correct solution and a well written proof
4 pts	Most of the required ingredients are present, but there are a few technical problems with the solution
3 pts	Some of the needed ideas are present. However, the solution either lacks the final conclusion or has some problems in the exposition
2 pts	The proof has at most one or two of the needed ideas and/or the proof is poorly written
1 pt	An attempt to the solution has been made, but there is a major flow in the logic of the proof, or the proof is not well written
0 pts	Little or no progress is made toward the solution

Exams (2 Midterms, 1 Final Exam)

There will be two midterms and a cumulative final exam (2.5 hours). Both midterms will be held during class time (50 minutes). I will give more details about the tests nearer to the test dates. The tentative dates of the midterm are:

Test	Dates
Midterm Test 1	Feb. 11, 2022
Midterm Test 2	March 18, 2022

For all midterms and the final, you must bring your student ID. You can use McMaster Standard Calculator, that is, the Casio fx-991 MS or Casio fx-991 MS Plus.

Evaluation

Your mark will be calculated in two different ways. I will take the higher mark of the following two methods.

Grade Component	Weight 1
Homework (best 8 out of 9)	20%
Midterm 1	20%
Midterm 2	20%
Final Exam	40%

Graded Component	Weight 2
Homework (best 8 out of 9)	20%
Max among {Midterm 1, Midterm2}	20%
Final Exam	60%

Important Dates

Topics	Dates
Classes Begin	Jan 10, 2022
Term Test 1 (tentative)	Feb 11, 2022

Mid-term recess	Feb 21-25, 2022
Last day for canceling courses without failure by default	Mar 18, 2022
Term Test 2 (tentative)	Mar 18, 2022
Classes End	Apr 12, 2022
Final Exams	Apr 14-29, 2022

Virtual Course Delivery (if needed)

To follow and participate in virtual classes it is expected that you have reliable access to the following:

- A computer that meets performance requirements found here.
- An internet connection that is fast enough to stream video.
- Computer accessories that enable class participation, such as a microphone, speakers and webcam when needed.

If you think that you will not be able to meet these requirements, please contact uts@mcmaster.ca as soon as you can. Please visit the Technology Resources for Students page for detailed requirements. If you use assistive technology or believe that our platforms might be a barrier to participating, please contact Student Accessibility Services, sas@mcmaster.ca, for support.

Requests for Relief for Missed Academic Term Work

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, lasting fewer than 3 days, you may report your absence, once per term, without documentation, using the McMaster Student Absence Form (MSAF). Students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

MSAF Course Specific Information

Absences for a longer duration or for other reasons must be reported to your Faculty/Program office, with documentation, and relief from term work may not necessarily be granted. **In Math 2R03, the**

percentages of the missed work will be transferred to the final examination. Please note that the MSAF may not be used for term work worth 25% or more, nor can it be used for the final examination.

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 to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

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.

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.

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.

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*, 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 the McMaster Office of Academic Integrity's webpage.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all 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.

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.

Research Ethics -NA

Extreme Circumstances

The instructor and university reserve the right to modify elements of the course during the term. 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. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.