University of Manitoba
Department of Mathematics, Faculty of Science
September–December 2019

Course Number and Title: MATH 1210 Techniques of Classical and Linear Algebra

Number of Credit Hours: 3

Pre-requisites: **A** minimum grade of 60% in Pre-calculus Mathematics 40S or the former Mathematics 40S (300), or a grade of 60% or better in the Mathematical Skills course taught by Extended Education

Class Times and Locations:

Section A01 Monday, Wednesday, Friday 9:30 – 10:20 in Buller 207

Section A02 Monday, Wednesday, Friday 1:30 – 2:20 in Armes 201

Section A03 Monday, Wednesday, Friday 12:30 – 1:20 in Armes 205

Tutorial Times and Locations:

B01: Friday 8:30 – 9:20 in Allen 319
B02: Friday 10:30 – 11:20 in Machray 415
B03: Friday 1:30 – 2:20 in Machray 415
B04: Friday 2:30 – 3:20 in Machray 415
B05: Monday 8:30 – 9:20 in Machray 124
B06: Monday 8:30 – 9:20 in Allen 319
B07: Monday 10:30 – 11:20 in Machray 315
B08: Monday 11:30 – 12:20 in Machray 415
B09: Wednesday 8:30 – 9:20 in Allen 319
B10: Wednesday 10:30 – 11:20 in Machray 315
B11: Wednesday 1:30 – 2:20 in Machray 415
B12: Wednesday 4:30 – 5:20 in Allen 319

Instructor information:

Section	Instructor	Office	Telephone	Email
A01	J. Chipalkatti	MH534	474-6924	Jaydeep.Chipalkatti@umanitoba.ca
A02	J. Chipalkatti	MH534	474-6924	Jaydeep.Chipalkatti@umanitoba.ca
A03	D/ Trim	MH522	474-8760	Donald.Trim@umanitoba.ca

Office hours for instructors are posted on their office doors.

I will endeavour to be in my office at these times, but unforeseen circumstances may sometimes prevent me from being there, and I apologize for this. If these hours do not fit your schedule, I am willing to discuss an alternative time for an appointment. If my door is open at any time outside official office hours, feel free to ask me any questions concerning the course. If the door is closed, I am either not in or prefer not to be disturbed. When you have difficulty with a certain exercise, and you wish to discuss it with me, bring whatever attempts you have made to solve the problem. This makes it much easier for me to diagnose what is troubling you.

It is my practice to read my email first thing each morning (and sometimes at other times during the day). I will endeavour to answer any inquiries within 24 hours.

Web Page: The web page for the course can be found at home.cc.umanitoba.ca/~dtrim/

Follow the links to this course.

Web Page for Old Tests and Exams: www.math.umanitoba.ca/courses

Web Page for Archived Material: R.S.D. Thomas has archived material for this course over a number of years. Examine it to see if it is personally helpful to you in your studies. It can be found at home.cc.umanitoba.ca/~thomas/Courses

Past examinations are for practice only. There is no guarantee that your examinations in this course will be similar to examinations from previous years.

Calendar Description of Course:

To introduce a variety of practical algebraic concepts and skills necessary for the study of calculus and advanced engineering mathematics. The emphasis of this course is in the development of methodology and algebraic skill necessary for successful completion of subsequent engineering mathematics courses.

A more Detailed Description of the Course:

Subject matter for the course breaks into three units. The first unit is Chapter 1 wherein you will prove results by mathematical induction, and use sigma notation to represent sums symbolically. The second unit is Chapters 2 and 3. In Chapter 2, you will learn to represent complex numbers in Cartesian, polar, and exponential forms, and how to add, subtract, multiply, divide, and find roots of complex numbers. In Chapter 3, you will become familiar with properties of polynomial

equations, and use the rational root theorem, Descartes' rules of signs, and a bounds theorem to find roots of polynomial equations. The last unit consisting of Chapters 4-9, is commonly referred to as linear algebra. Matrices and how to add, subtract, and multiply them are discussed in Chapter 4. In order to have a geometric interpretation of material in Chapters 6-9, vectors and their application to equations for lines and planes in three-space are presented in Chapter 5. In Chapter 6, you will learn how to solve systems of linear equations by Gaussian and Gauss-Jordan elimination. Chapter 7 introduces determinants and applies them to linear systems through Cramer's rule. This chapter also discusses the concept of linear dependence and linear independence of sets of vectors. Inverses of matrices are introduced in Chapter 8. You will learn how to calculate inverse matrices by the direct and the adjoint methods, and use them to solve linear systems. Chapter 9 deals with linear transformations, their representations as matrices, and eigenvalues and eigenvectors.

Goals: The course has four main goals:

1. to introduce you to sigma notation and proof by mathematical induction
2. to introduce you to complex numbers, and to familiarize you with properties of, and solution techniques for, polynomial equations
3. to introduce you to three-dimensional geometry
4. to familiarize you with the basics of linear algebra, including matrices and their inverses, solving systems of linear equations, determinants, linear transformations, eigenvalues and eigenvectors.

Instructional Objectives: At the completion of the course, the student is expected to be able to:

1. decide when and how to use mathematical induction to prove mathematical results
2. use sigma notation to represent summations in compact form
3. write complex numbers in Cartesian, polar, and exponential form, and find roots of complex numbers
4. find solutions of polynomial equations using the factor theorem, the rational root theorem, the bounds theorem, and Descartes' rules of signs
5. calculate dot and cross products of vectors, and use vectors to find equations for lines and planes in space
6. use augmented matrices along with Gaussian and Gauss-Jordan elimination to solve systems of linear equations
7. evaluate determinants and use Cramer's rule and inverse matrices to solve linear systems
8. determine whether a set of vectors is linearly independent or dependent
9. represent linear transformations as matrices and find their eigenvalues and eigenvectors

Textbook: Notes for Course MATH 1210: Techniques of Classical and Linear Algebra by Donald Trim (2012)

These notes contain all of the material for the course. You will want to digest the material thoroughly, not only to pass this course, but because the material is essential to many of your future courses in Engineering. You will not master mathematics simply by reading it; you must engross yourself in it. Here are some suggestions on how to study with the notes:

1. Ideally, pre-read material before each class. Below is a class schedule so that you will know what is to be covered each day. You will get much more out of class if you have some prior knowledge of the material.
2. Attend class. Learning begins in class, but only begins here. The amount of learning acquired in class is directly related to how much you put into the class. You should attempt to be involved in class discussions. You are much more likely to remember a discussion if you are involved in it.
3. You may take notes or you may choose not to take notes. If you do take notes, copy, or paraphrase, only what is on the board. Do not attempt to copy everything that I say; that, as you will soon see, is impossible. I love mathematics, and as my excitement grows, so also can my speed of delivery. But remember, I wrote the notes so everything important is there.
4. As soon as possible after class has finished, and therefore when ideas are still fresh in your mind, read the corresponding material in the notes, and do some of the exercises. This is when real learning starts to take place. If you encounter difficulties with exercises that have no asterisk, then you have missed some key idea, and should therefore consult with me as soon as possible. Keep all solutions as they are an excellent source of review material for assignments and exams.
5. The notes contain answers to all exercises, and detailed solutions to even-numbered exercises (except the challenging two-asterisk exercises). Again, these solutions are not simply reading material. They should be consulted once you have finished an exercise and you wish to compare your method of solution with mine. Additionally, if you spend a reasonable amount of time attempting an exercise, but get nowhere, then take a brief glance at my solution to get yourself started, and then continue on your own.

Class Schedule: Below is a plan for each class. It is subject to change due to unforeseen difficulties in presentation of material and at the discretion of instructors.

Date of Class	Chapter.Section	Suggested Exercises
Sept 6	1.1	2-34, 38-44
Sept 9	1.1	
Sept 11	1.2	2-34
Sept 13	2.1	2-42
Sept 16	2.1	
Sept 18	2.2	2-34
Sept 20	2.2	
Sept 23	2.2	
Sept 25	3.1	2-26
Sept 27	3.1	
Sept 30	3.2	2-40
Oct 2	3.2	
Oct 4	4.1	2-22
Oct 7	4.1,4.2	2-20,24,26
Oct 9	5.1	2-34
Oct 11	5.2	2-24
Oct 16	5.2	
Oct 18	6.1	
Oct 21	6.1	
Oct 23	6.2	2-22
Oct 25	6.3	2-26
Oct 28	6.4	2-22,26-34
Oct 30	7.1	2-18
Nov 1	7.1	
Nov 4	7.2	2-10
Nov 6	7.3	2-14
Nov 8	7.3	
Nov 18	8.1	2-8
Nov 20	8.2	2-16
Nov 22	8.3	2-16
Nov 25	8.4	2-12
Nov 27	8.4,8.5	
Nov 29	9.1	2-8
Dec 2	9.2	2-8,12
Dec 4	9.3	2-10
Dec 6	9.4	2-6

We have suggested some **even-numbered** exercises for you to do. They represent a minimum number of exercises that should be attempted. The more exercises that you do, the better, so try doing some of the odd-numbered exercises also. Doing the minimum does not guarantee a pass in the course. It should be noted that exercises with no asterisk * are considered to be routine problems. Difficulty with these exercises indicates a definite lack of understanding of associated material and help should be sought. Exercises with a single star are more difficult; they may require more intensive calculations or some creative thinking. Exercises with two asterisks are challenging and should be attempted only when other exercises have been mastered.

Tutorials: Each Friday tutorial problems for the following week will be posted on the course web page. You are to attempt to solve the problems **before** the tutorial. The teaching assistant will help you with difficulties that you encounter with the tutorial problems or difficulties that you have with exercises from the notes.

Evaluation: There are three components contributing to the final grade in the course.

1. Three assignments each counting 5%. Assignments will be posted on the web page for the course on Fridays. They will be due on the table at the front of the classroom prior to the start of class on the next Friday. Late assignments will not be accepted. We suggest that you start the assignment on the weekend it is posted. If you encounter difficulties, you will have plenty of time to have them resolved. With a week to finish the assignments, there is no excuse for not getting an excellent mark. **Copying will not be tolerated.** We have no problem with you working in groups, and we even encourage you to do so, but the final write up must be your own. Attached to each assignment must be an honesty declaration which can be downloaded from the web page for the course; it attests to the fact that your submission is your own. The assignments may be lengthy, and only a selection of the problems will be marked. Solutions to the assignments will be posted on the next Monday. The schedule for assignments is as follows:

Assignment	Date to be posted	Date due
1	September 27	October 4
2	October 18	October 25
3	November 22	November 29

2. A 75-minute midterm counting 30% The midterm will be on Thursday, October 31 from 5:45 to7:00 in rooms that will be announced in class and posted on the website for the course. You will be responsible for Chapters 1-5 on the midterm. If you

miss the midterm and can provide an acceptable reason for doing so, accompanied by supporting evidence, you will be given the opportunity to write a make-up test.

3. A two-hour final exam counting 55%. The final exam is scheduled by Student Records. It covers the entire course, with material after the midterm weighted more heavily than material prior to the midterm.

   Notes, books, calculators or other computing devices are not allowed for the midterm or the final exam.

Grading: The following can be used as a guide in changing numerical grades to letter grades. It is only a guide, however, as fluctuations in grade lines may occur.

Numerical Grade	Letter Grade
92-100	A+
83-91	A
77-82	B+
71 -76	B
65-70	C+
60-64	C
50-59	D
0-49	F

Voluntary Withdrawal Date: Voluntary withdrawal date is November 18, 2019.

Academic Dishonesty:

The Department of Mathematics, the Faculty of Science and the University of Manitoba all regard acts of academic dishonesty in quizzes, tests, examinations or assignments as serious offences and may assess a variety of penalties depending on the nature of the offence.

Acts of academic dishonesty include bringing unauthorized materials into a test or exam, copying from another student, plagiarism and examination personation. Students are advised to read section 7 (Academic Integrity) and section 4.2.8 (Examinations: Personations) in the General Academic Regulations and Requirements of the current Undergraduate Calendar. Note, in particular, that cell phones and pagers are explicitly listed as unauthorized materials, and hence may not be present during tests or examinations.

Penalties for violation include being assigned a grade of zero on a test or assignment, being assigned a grade of "F" in a course, compulsory withdrawal from a course or program, suspension from a course/program/faculty or even expulsion from the University. For specific

details about the nature of penalties that may be assessed upon conviction of an act of academic dishonesty, students are referred to University Policy 1202 (Student Discipline Bylaw) and to the Department of Mathematics policy concerning minimum penalties for acts of academic dishonesty.

All students are advised to familiarize themselves with the Student Discipline Bylaw, which is printed in its entirety in the Student Guide, and is also available on-line or through the Office of the University Secretary. Minimum penalties assessed by the Department of Mathematics for acts of academic dishonesty are available on the Department of Mathematics web-page.

Available support services: The following services are available to students encountering difficulties in adjusting to university life:

- The **Learning Assistance Centre**, located in 201 Tier, offers services that may be helpful to you as you fulfill the requirements of this course, and others. You may meet with a study skills specialist to discuss concerns such as time management, reading and note-taking strategies, as well as test-taking strategies.

- **Student Accessibility Services** (SAS) provides support and advocacy for students with disabilities of all kinds: hearing, learning, injury-related, mental health, medical, physical or visual. Students with temporary disabilities, such as sprains and breaks are also eligible to use SAS services. SAS acts as a liaison between students and faculty as well as support agencies within the province. Phone 474-6213.

- **Student Counselling and Career Centre** offers individual, couple or family counselling in individual and group formats. Phone 474-8592.

- **The English Language Centre** offers workshops and programs in advanced academic and health-sciences English (located in 520, University Centre)

This is what you can expect of me:

- make every effort to plan the course and each class so that learning will be maximized
- arrive five minutes early and begin class at precisely the appointed time
- conduct classes, and not give lectures. I will explain this under my expectations of you.
- be patient when you struggle with ideas (struggling reveals that learning is taking place)
- be open to suggestions (Suggestions can often lead to improvements in a course.)
- treat you as adult learners, with related respect
- provide you with plenty of office hours for consultations I encourage you to see me during office hours as soon as you encounter difficulties. Do not delay.

This is what I expect of you:

- be punctual. The first few moments of a class are the most important. There is often a quick review of the main ideas from the last class and how they lead into the present class. General ideas and the "big picture" are often discussed in the first few moments. You are doing yourself a disservice by missing these discussions (as well as perhaps disturbing me and the rest of the class by being tardy).
- participate in class, which includes both speaking up and listening. Learning begins in class but most of it takes place when you study. Learning will begin here only if you contribute to the class; what you put into a class is directly related to what you get out. I will ask you many questions in the course of a class and for many different reasons. Your learning is substantially enhanced if you offer an answer, or at least formulate one. Do not come to class for the sole purpose of taking notes; that does not contribute to your learning. In order to answer many of the questions that I will pose, it is necessary for you to be familiar with what has transpired in recent classes. Try to keep up. Even better would be for you to read ahead. Part of this syllabus is a day-by-day schedule of sections to be covered. If you pre-read material, you will get far more out of class.
- be courteous when others are speaking. Only one person should be speaking at any given time during class. If you repeatedly have conversations with your neighbour while others are discussing course material, I will ask you to leave the room.
- complete all requirements of the course.
- use college-level, mathematical writing, legible and with correct format. There are many worked out examples in the notes; these should guide you on how to write solutions to problems on assignments and in tests. In addition, the notes contain detailed solutions of even-numbered exercises, a further guide on how to present solutions.
- be honest. Submissions must be your own work.
- have the courage to ask questions in class if something is not clear. If you have a problem, it is quite possible that someone else has the same problem. I will attempt to clear the difficulty immediately. Should I not be able to do so, I may ask you to see me after class for further clarification.
- discuss difficulties that you are having with course material as quickly as possible. The longer you leave a difficulty unresolved, the more unbearable it becomes, and the further and further behind you become. I have plenty of office hours, or you can see me immediately before or after class to set up a special appointment.
- turn off cell phones when entering class.