Math 426/626, Section 01 **TR 2:00–3:15 pm, W01-0047**

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Math 426/626—
Syllabus for Section 01

Spring 2024

General Course Procedures and Information

Catalog Description

This course is a continuation of linear algebra, towards topics relevant to applications as well as theoretical concepts. Topics to be discussed are algebraic systems, the singular value decomposition (SVD) of a matrix and some of its modern applications. We will discuss Principal Component Analysis (PCA) and its applications to data analysis. We will study linear transformations and change of basis. We will discuss complex vector spaces and Jordan canonical form of Matrices. We will discuss non-negative matrices and Perron-Frobenius Theory. We will explain multiple matrix factorisations, such as LU, QR, NMF. Finally we will discuss other applications such as the Fast Discrete Fourier Transform. For each of these topics we will discuss numerical computer algorithms and their implementations. In particular we will discuss in detail eigenvalue estimation, including iterative and direct methods, such as Hausholder methods, tri-diagonalzation, power methods, and power method with shifts. We will explain concepts of numerical analysis that are important to consider when we talk about the implementation of algorithms, such as stability and convergence. We will discuss iterative methods as well as direct ones, their advantages and disadvantages. The methods are their applications will be illustrated using a common programming language such as python and/or R.

Grading Policies

Letter grades are assigned as follows:

A	93-100	C	73-76
A-	90-92	C-	70-72
B+	87-89	D+	67-69
B	83-86	D	63-66
B-	80-82	D-	60-62
C+	77-79	F	below 60

The course grade will be calculated according to the percentages below:

Homework Average	17%
Quiz Average	18%
In-class Exam	30%
Final Exam	35%

Non-Attending (NA) Grades

If you are not planning to attend this course, then it is strongly recommended that you act immediately to drop the course prior to the add/drop deadline of Monday, January 29, 2024. According

to University policy described at https://www.umb.edu/registrar/ policies/na-grade/, if you do not attend any course meetings during the first week of class and do not drop the course, you may receive a grade of NA. In that case, you will still be responsible for all tuition and fees associated with the course but will not be eligible to receive a letter grade; hence it is strongly recommended that you drop the course by Monday, January 29, 2024 at 11:59pm if you do not plan to attend.

Incompletes (INC)

The grade of incomplete is reserved for cases where the student would otherwise have passed the course but has missed a small portion of the coursework due to unavoidable circumstances. In that case, the missed work must be made up according to a prearranged schedule, agreed upon by the instructor and student. Failure to adhere to the agreed schedule will automatically change the grade of I to F.

Expectations

The purpose of this section is to clearly present to you what the Mathematics Department must expect of students in support of their own success, and of the essential ways in which the Department expects instructors to support your success. Please review the lists below, and **come back to this section if you ever feel confused about how to improve your performance in your current math class.**

You may find these expectations shocking, but it is the sober consensus of a large number of experts that success in university-level mathematics courses is not possible unless students commit to the following:

1. Attend all classes and take good notes.
2. Spend 10–15 hours per week outside of class reading, studying, doing homework, and working additional practice problems of your own choosing, until you have achieved thorough mastery of concepts and high accuracy and fluency in computation.

   (This is not a typographical error or a mistake. Mathematics is a unique subject which requires more study and practice to achieve mastery than many other subjects. You would not expect to master the use of a musical instrument without considerable time spent practicing, and you should think of Mathematics in much the same way. This subject is foundational to many other subjects, especially in science and technology, and time spent achieving thorough mastery will have a very high return on investment.)
3. Thoroughly review lecture notes until knowledge gaps are filled.
4. Work on problems outside of class and do more problems than assigned for homework, again referring to the lecture notes when knowledge gaps arise.
5. Take responsibility for thorough mastery by asking questions in class and/or seeking extra help whenever this is necessary.

In return, students should expect instructors to support their learning in the following ways:

1. Clearly communicate the objectives of the course.
2. Distribute the syllabus.
3. Clearly communicate the due dates of homework assignments and the dates of exams.
4. Return graded work in a timely fashion, normally within two weeks of its due date.
5. Clearly identify the study resources (textbook, tutoring, etc.) available to students and appropriate for their use in this course.

Approaching the course with these expectations in mind will dramatically improve your likelihood of success in this course.

Communication

Communication between students and instructor are essential. For this reason, the instructor will set up a few different ways to reach out. First, is email. This method is recommended if it is in regards to grades or requesting to reschedule an exam. Please be aware that there is often a delay of one to two days before a response is given. If no response is given after 2 business days, and a response is expected, please send out a new email (not forwarding the original email) that contains the contents of the original email and the day the original email was sent. Second, is the Guilded server. This method is recommended for asking math questions or due dates of upcoming assignments. It is also recommended that you send Direct Message through Guilded if a quick response is needed. Please note there still could be a delay, but a response if often given within 24 hours. The last method is Blackboard messages. This should only be used if all other methods have been tried and you have not received a response. Blackboard messages are rarely checked, but can be used as proof you did reach out. If you are experiencing difficulties, whether academic or personal, it is important that reach out sooner rather than later. Waiting until the end of the semester could limit the options available as opposed to those available at the beginning. It also may take time to get the resources needed to assist you.

Student Conduct

Students are required to adhere to the University Policy on Academic Standards and Cheating, to the University Statement on Plagiarism and the Documentation of Written Work, and to the Code of Student Conduct. The section of the Code pertaining to academic honesty is available online at the following URL:

https://www.umb.edu/editor_uploads/images/life_on_campus/FINALUMBCode9-5-18-Appendix_B_V2.pdf

Violation of these policies will result in disciplinary action, as described in section B.II of the Code.

Accommodations for Students with Disabilities

Section 504 of the Americans with Disabilities Act of 1990 offers guidelines for curriculum modifications and adaptations for students with documented disabilities. If applicable, students may obtain adaptation recommendations from the Ross Center for Disability Services, CC-UL-211, (617-287-7430). The student must present these recommendations and discuss them with each professor within a reasonable period, preferably by the end of the Drop/Add period.

Complaint Procedure

If issues arise regarding the design of this course or the conduct of the instructor, the proper complaint procedure is to first make a good-faith effort to resolve the problem by speaking with the instructor. If this fails, students may contact the Chair of the mathematics department. Current contact information for these individuals is given below:

Department Chair: Alfred Noël `<Alfred.Noel@umb.edu>`

Course Structure

Textbook Reading

It is expected that you read through the relevant textbook section prior to the topic being covered in class. At the beginning of each week the expected topics to be covered should be posted on Blackboard. In addition to reading about the topic you should also utilize the textbook to practice problems in addition to those assigned.

Required Textbook

The textbook is James W. Demmel, *Applied Numerical Linear Algebra*. This textbook will follow the structure of the course. However, additional textbooks and reference material will be provided on Blackboard.

Lectures

Lectures will be held in person as scheduled on Wiser. There is an expectation that you attend every class. If circumstances are such that you are not able to attend class it is your responsibility to make up any missed material, if applicable. It is strongly encouraged that you reach out to your instructor to make sure you have not missed any important announcements or assignments.

Attendance

Students are expected to regularly attend class and are responsible to complete all scheduled in-class work, such as midterms and quizzes, at the regularly scheduled times, unless an absence is authorized by the Dean of Students Office, as described in the university-wide attendance policy:

`https://www.umb.edu/registrar/policies/attendance`

Assignments

All grades will eventually be posted to Blackboard. If anything is incorrect when posted on Blackboard let the instructor know as soon as possible. If you suspect a grade a missing on Blackboard, but is posted elsewhere allow at least two weeks after the grade is posted to let the instructor know.

Test and Quizzes

There will be three in class exam and one final exam. Quizzes will occur once a week except for an exam week. Your lowest quiz grade will not be included in the final grade calculations. Quizzes and exams cannot be taken later unless there is a legitimate reason. In this case, the instructor must be notified before, the time in which the exam or quiz is scheduled, or as soon as you are able. It is the student's responsibility to arrange a time to take to an exam or quiz within one week of the original deadline. Exceptions may be made for unavoidable extended absences. Please contact the instructor as soon as possible in this situation, it is also recommended that you contact the dean of students to discuss your options. Exams and quizzes will be closed notes and closed book. Work and justification will be required for each and every problem. Missing steps or lack of details could result in a deduction of points. If the skipped step cannot be done on a basic calculator, hitting the equal sign no more than once, it will be considered insufficient work. By doing the written homework you should be able to understand what is considered "sufficient work" through the feedback provided. We may certainly discuss this further if you are not sure what is considered "sufficient work".

Travel During the Final Exam Period

This course has a final exam during the period **May 13–17, 2024.** The exact time of the final is determined by the Registrar's Office, and will be posted on WISER around the middle of the semester. Students must not make travel arrangements which might conflict with their responsibility to take the final exam at the appointed time. In particular, **a purchased airline ticket does not constitute a valid excuse to miss the final, and no makeup exam will be granted under these circumstances.**

Conflict finals

University policy specifies that any student who has two final exams scheduled at the same time, or who has three or more final exams scheduled on the same day, is eligible to reschedule one of the

exams. Under these circumstances, students who wish to reschedule their final exam in this class must notify the instructor in writing **no later than Monday, May 6, 2024.** You must include the course number, the section number, your name, and your student ID number in this notification. Department staff will then verify your eligibility to reschedule, and assign you to an alternate testing time if appropriate.

Homework

Two or three problems will be assigned approximately each week and due the following week. These assignments will focus on writing a well justified solution and the ability to write code for the algorithms introduced in class. The focus should be on your work and not the solution. The assignments may be handed in during class or submitted through Blackboard. You may hand write your solution and take a picture in a well-lit room and upload to Blackboard. However, if you do upload your work to Blackboard the file type must be pdf, word document, or a fairly common image file (such as .jpg). If a request to submit a code is requested please do submit the file with a python extension unless told otherwise.

Tentative Schedule of Topics

Week 1: Introduction, Basic matrix operations

Week 2: Gaussian Elimination (LU decomposition)

Week 3: Improving error and special matrices of Gaussian Elmination

Week 4: Linear Least Square and QR decomposition

Week 5: SVD and Householder methods

Week 6: Nonsymmetric Eigenvalues problems-Intro and perturbation theory

Week 7: Nonsymmetric Eigenvalues problems-Algorithms

Week 8: Symmetric Eigenvalue problems-Intro and some algorithms

Week 9: Symmetric Eigenvalue problems-Additional algorithms involvinf SVD

Week 10: Iterative methods

Week 11: Fast Fourier Transform

Week 12: Perron-Forbenius Theory

Week 13: Additonal Practice with NMF factorization

Week 14: Review and/or additional practice with methods introduced