Marshall University Syllabus

Course Title/Number	**Math 642: Numerical Linear Algebra**
Semester/Year	Spring 2017
Days/Time	Monday and Wednesday 5:00pm – 6:15pm
Location	Smith Hall 514
Instructor	Carl Mummert
Email	mummertc@marshall.edu
Phone	304 696-6156
Office	Morrow Library 110
Office Hours	• Monday and Wednesday 9:30am – 10:45am • Tuesday and Thursday 2:00pm – 3:15pm I am also glad to meet by appointment. My door is always open.
University Policies	By enrolling in this course, you agree to the University Policies listed below. Please read the full text of each policy by going to www.marshall.edu/academic-affairs and clicking on "Marshall University Policies." Or, you can access the policies directly by going to http://www.marshall.edu/academic-affairs/policies/. *Policies:* Academic Dishonesty / Excused Absence Policy for Undergraduates / Computing Services Acceptable Use / Inclement Weather / Students with Disabilities / Academic Dismissal / Academic Probation and Suspension / Academic Rights and Responsibilities of Students / Affirmative Action / Sexual Harassment.

Course Description From Catalog

Direct and iterative methods for numerical solution of linear systems of equations. Eigenvalues and eigenvectors. Error Analysis and norms. Related topics and applications. 3 Credit Hours

Required Texts

- *Numerical Linear Algebra* by Trefethen and Bau, Paperback, ISBN 0-8987-1361-7.

Prerequisites

- **MTH 443, MTH 643**, or permission of instructor.
- **Programming experience.** Familiarity with fundamental imperative programming techniques: conditional statements, loops, function calls, structured programming. Ability to implement algorithms based on a written description. In this class we will primarily use the Python language, but we may use other languages from time to time.

Course Student Learning Outcomes

The table below shows how each student learning outcome will be practiced and assessed in the course.

Student Learning Outcome	How students will practice this outcome	How student achievement of this outcome will be assessed
Students **will be able to recall and state key definitions and theorems of numerical linear algebra.**	In-class discussion, written homework	Exams, portfolio
Students **will be able to produce both routine and novel implementations** of numerical linear algebra methods.	In-class discussion, programming assignments	Exams, portfolio
Students **will be able to prove the correctness of numerical linear algebra methods**.	In-class discussion, written homework	Exams, portfolio
Students **will be able to recall, synthesize, and create examples** of numerical linear algebra problems with particular properties.	In-class discussion, written homework	Exams, portfolio
Students **will be able to demonstrate proficiency in multiple programming languages** appropriate for numerical linear algebra.	Programming assignments	Portfolio
Students **will be able to write proofs at a level appropriate for a senior mathematics major.**	In-class discussion, written homework	Exams, portfolio
Students **will produce quality computer code** at a level appropriate for undergraduate mathematics majors	In-class discussion, homework	Exams, portfolio

Attendance policy

Attendance at all class meetings is expected, with the same general standards as absences at a place of employment. If you cannot be present at a class, please email me before class to let me know. Attendance will be taken at the start of class. Make-up exams will be given only for excused absences, and late submissions will be accepted only for excused absences.

Academic honesty policy

Plagiarism or academic dishonesty of any kind is not permitted. The expectation is that all work you submit is your own, and that all uses of reference material are attributed appropriately. The university policy on academic dishonesty has additional details about the definition of plagiarism. There is a course-specific academic honesty policy later in this syllabus.

Audio/visual recording policy

You are permitted to make audio recordings of this class, provided that you notify me in advance. I will notify the class so they are also aware. Recordings must be deleted after the semester ends. If you have an accommodation from the Office of Disability services that relates to audio/visual recording, it will be honored; please contact me.

MU Online

It is important to visit MU Online regularly for up-to-date information about the course. All course materials including assignments, handouts, lecture notes, and reading materials will be posted there. MU Online is the official source for all assignments.

Shared Linux class server

You will have access to a shared Linux computer at `mummert-class.marshall.edu`. This computer is located in my office and is accessible via SSH from campus or using the VPN. You will be required to use this computer for some programming assignments.

- If you are not familiar with Linux, there are many web guides available. Links to selected resources will be provided on MU Online.
- Usage of the class server is subject to the University Computing Services Acceptable Use Policy, which is available at http://www.marshall.edu/academic-affairs/policies/.
- Use the class server only for programming assignments, and do not store any personal or sensitive information on it.

Course Expectations

- Keep up with the course. The difficulty of the course increases greatly if you fall behind. You need to be conversant with the definitions and theorems we have already covered, which will require studying between classes.
- Engage with the material during class and ask questions about topics you do not understand. You can ask questions during class, or after class in person or by email.
- Begin the homework and programming assignments early, and work on them in phases. Rushed homework assignments are usually of lower quality.
- Make use of my office hours to discuss any material you find difficult. You should plan to come to my office at least once before each exam.
- Arrive at class on time and remain in the class for the entire duration of the class, unless there are unavoidable conflicts.
- You are welcome to step out of class to take phone calls when necessary, except during exams. Please put all phones and other noisemakers in silent mode during class.

Assignments and due dates

- **Written homework** will be due about every 2 weeks. These will be written assignments to help you learn the theoretical aspects of the course material. Homework may be due on days other than Monday and Wednesday.
- **Programming assignments** will also be due about every 2 weeks. These assignments will help you learn how the theory of the course is put into practice via programming languages. Programming assignments may be due on days other than Monday and Wednesday.
- **Written Exams** will be given during class on February 15, 2017 and April 12, 2017.
- A **Portfolio** will take the place of the final exam. A rough draft will be due on March 29. The final version is due at 5:00pm on May 1, 2017.
- A cumulative **Oral Exams** will be given during finals week. No later than the last day of class, you must schedule the day and time when you will take the oral exam.

The exams and proof portfolio are the **major assignments**, and have extra weight in the overall grade.

Important dates

- January 9: First day of class
- February 15: In-class exam 1
- March 29: Rough draft of portfolio due at 5:00pm
- April 12: In-class exam 2
- April 26: Last day of class
- May 1: Final portfolio due at 5:00pm.

Grading Policy

This course will have a **nonquantitative** grading system. This means that, rather than giving feedback as an opaque number, I will give feedback that is more directly meaningful. The grading system is based on several rubrics that will be distributed along with this syllabus.

Mastery rubric I will use this to assess the level of mastery that is demonstrated on all assignments. The mastery rubric is on pages M-1 and M-2 of this syllabus. It has detailed definitions of the following *levels of mastery*:

- **Graduate mastery (GM):** the level of mastery expected for an A in a graduate course.
- **Undergraduate mastery (UM):** the level of mastery expected for an A in an upper-level undergraduate course.
- **Partial mastery (PM):** a beginning level of mastery that does not reach the level of undergraduate mastery.
- **Not meeting expectations (NE):** this level is assigned to assignments that are incomplete or contain significant errors.
- **No submission (NS):** this level is assigned when an assignment was not submitted, or was extremely incomplete.

Proof grading rubric The proof grading rubric shows the grading levels for proofs that you submit in the class. The rubric is on page PG-1 of this syllabus.

Program grading Grading standards for programming assignments will be distributed on MU Online.

Grade combining rubric This rubric shows how the grades from different assignments are combined to give an overall course grade. The rubric is on page C-1 of this syllabus.

Homework resubmission policy Homework assignments that are graded NE or NS may be resubmitted *one time* for re-grading, provided that you meet with me during office hours to discuss the assignment before re-submitting it. The second grade will replace the original grade. Re-submissions must be submitted the second class meeting after our meeting in office hours. Re-submissions that do not follow the preceding guidelines will not be accepted.

Letter grades The following table shows the letter grade associated with each level of mastery.

Level	Grade for undergraduate	Grade for graduate
GM / Graduate mastery	A	A
UM / Undergraduate mastery	A	B
PM / Partial mastery	B	C
NE / Not meeting expectations	C	D
NS / No submission	F	F

Course-Specific Academic Integrity Policy

- On homework assignments, you may collaborate with other students. However, you may not copy answers from any source, and what you write must reflect your own understanding.
- Each programming assignment is either an individual assignment or a group assignment. For individual assignments, you may not obtain assistance from any other individuals – including other students in the class, relatives, or any other individuals. For group assignments, you may obtain assistance only from other members of your group.
- *Do not show your own computer code to other students*, except for students in your own group for group assignments. Sharing code on individual programming assignments will be treated as academic dishonesty.
- If you use computer code from any other source (including other students, online resources, other texts, etc.), you must clearly attribute the code with a comment that names the place you obtained the code, including a URL if applicable, and the author of the code, if known.

Penalties for Academic Dishonesty

- The first incident of academic dishonesty by a student will result in a grade of zero on the assignment and a formal report filed with Academic Affairs.
- The second case of academic dishonesty by a student will result in a grade of F in the course and a formal report filed with Academic Affairs.
- A student who has been given a penalty for academic dishonesty is not permitted to withdraw from the course in order to avoid the penalty.

Last updated: January 1, 2017

Mastery Rubric

	GM: Graduate Mastery	UM: Undergraduate Mastery
Writing and clarity of expression	Writing displays extreme clarity of thought through the use of precise, non-verbose prose and appropriate use of mathematical symbolism. Proper mathematical terminology is used fluently throughout, in a manner demonstrating mastery of the meanings.	Writing displays clarity of thought through the use of clear prose and appropriate use of mathematical symbolism. Some paragraphs or sentences may be slightly unclear, verbose, or clunky. Rarely uses incorrect or clunky terminology; some use of terminology may not seem fluent.
Definitions	Able to recall all definitions from this course and previous courses. Able to state definitions clearly and precisely, and rephrase definitions for the problem at hand.	Able to recall all definitions from this course, and state the definitions clearly and precisely, with rare errors of limited significance. Can restate some definitions for the problem at hand, but may rely on rote memorization for stating some definitions.
Proofs	Proofs are correct and straightforward to follow, with clear organization. There are no logical or quantifier errors. All variables are clearly introduced. All proofs are at level 9 or 10 on the proof rubric. Straightforward proofs are at level 10 of the proof rubric.	Proofs are almost entirely correct, and are straightforward to follow, with clear organization, All variables are clearly introduced. Most proofs are at level 9 or 10 on the proof rubric; few are at level 7 or below.
Examples	Able to recall all examples seen in class, and determine additional properties of the examples. Able to construct new examples, some of which may be challenging.	Able to recall all examples seen in class, and to determine simple additional properties of the examples. Able to construct simple new examples by analogy with known examples.
Problem solving	Able to construct solutions to some challenging problems that have not yet been encountered. Able to solve all problems that have previously been encountered. Able to apply techniques in novel ways.	Able to construct solutions for problems that have already been encountered, with infrequent minor errors. Able to solve some novel problems that apply techniques similarly to previously encountered problems.

Mastery Rubric (continued)

	PM: Partial Mastery	NE: Not meeting expectations
Writing and clarity of expression	Writing sometimes shows clarity of thought, but at other times may be hard to follow or go off on tangents. Writing sometimes uses too little prose (too much symbolism). Occasional misuses of mathematical terminology, but not in ways that seriously jeopardize the answer.	Writing is unclear so that the main argument is difficult to follow. A large number of proofs may have minimal prose (symbolic derivation only), or excessively verbose prose. Significant errors in mathematical terminology, or excessive avoidance of mathematical terminology.
Definitions	Able to recall all definitions from the course, with occasional minor errors, and to state the definitions clearly and precisely. May rely on rote memorization. May struggle to apply definitions in proofs.	Unable to recall definitions from the course. Some definitions are stated with significant errors.
Proofs	Proofs have occasional errors, but generally not insurmountable ones. Proofs may appear to be rushed or unrevised. Many proofs are at level 8 or higher on the proof rubric; few are at level 6 or below.	Many proofs have significant errors. Majority of proofs at level 6 to 8 of the proof rubric, although a few proofs may be higher.
Examples	Able to recall most examples from class, although perhaps with minor errors. Unable to determine some simple properties of these examples. Unable to construct new examples.	Unable to recall many examples seen in class. Examples may be recalled with significant errors. Unable to determine new properties of already-seen examples.
Problem solving	Able to solve most straightforward exercises, but may struggle to solve novel problems. Occasional errors in applying basic proof strategies.	Unable to solve straightforward exercises that apply practiced techniques. Frequent errors applying basic proof strategies.

Proof Grading Rubric

	Surface features	Mathematical writing	Logical reasoning
10 **Mastery**	The problem is clearly stated. Grammar and spelling errors are rare. The formatting matches the submission guideline.	Variables are properly introduced before they are used. The use of quantifiers is clear. All symbols and terminology are used appropriately. The proof is written in polished prose.	The logical reasoning is correct and is clearly explained. The proof is complete: all cases have been examined, all significant steps have been justified, and all assumptions have been clearly stated. The proof is clearly organized and the argument is easy to follow.
8 **Partial Mastery (High)**	The problem is clearly stated. Grammar and spelling errors, if present, do not distract from the content. The formatting matches the submission guideline.	Some variables are used without being introduced. Symbols and terminology are used appropriately, with rare exceptions. The proof is written in prose.	The logical reasoning is essentially correct, although some parts are not clearly explained. Only minimal revision would be needed to correct the reasoning. All cases have been examined, all significant steps have been justified, and all assumptions have been clearly stated. The proof is organized well enough that the structure of the argument is clear.
6 **Partial Mastery (Low)**	The problem is clearly stated. Grammar and/or spelling errors distract from the content. The formatting does not meet the submission guideline.	Some variables are used without being introduced. Some symbols or terminology are used incorrectly. The bulk of the proof is written in prose.	The logical reasoning has a flaw that requires rewriting part of the argument. The proof is not complete: some case has not been examined, a significant step has not been justified, or an unspoken assumption has been made. Some parts of the argument are not clearly explained. The organization makes it difficult to discern the structure of the argument.
5 **Not Meeting Expectations**	The statement of the problem is missing or unclear. Grammar and/or spelling errors distract from the content. The formatting does not meet the submission guideline.	Some variables are used without being introduced. Some symbols are used inappropriately, or some terminology is used incorrectly. The proof is not written in prose form.	The logical reasoning has a serious flaw or multiple minor flaws. Significant revision is required to correct the argument. The proof is not complete: some case has not been examined, a significant step has not been justified, or an unspoken assumption has been made. Some parts of the argument are not clearly explained. The proof is not well organized.
0 **No Submission**	No solution is submitted, or the solution does not make progress on the assigned problem.		

Program Grading Rubric

	Completeness	Correctness	Coding style
10 **Mastery**	The problem is clearly stated. Grammar and spelling errors are rare. The formatting matches the submission guideline.	Variables are properly introduced before they are used. The use of quantifiers is clear. All symbols and terminology are used appropriately. The proof is written in polished prose.	The logical reasoning is correct and is clearly explained. The proof is complete: all cases have been examined, all significant steps have been justified, and all assumptions have been clearly stated. The proof is clearly organized and the argument is easy to follow.
8 **Partial Mastery (High)**	The problem is clearly stated. Grammar and spelling errors, if present, do not distract from the content. The formatting matches the submission guideline.	Some variables are used without being introduced. Symbols and terminology are used appropriately, with rare exceptions. The proof is written in prose.	The logical reasoning is essentially correct, although some parts are not clearly explained. Only minimal revision would be needed to correct the reasoning. All cases have been examined, all significant steps have been justified, and all assumptions have been clearly stated. The proof is organized well enough that the structure of the argument is clear.
6 **Partial Mastery (Low)**	The problem is clearly stated. Grammar and/or spelling errors distract from the content. The formatting does not meet the submission guideline.	Some variables are used without being introduced. Some symbols or terminology are used incorrectly. The bulk of the proof is written in prose.	The logical reasoning has a flaw that requires rewriting part of the argument. The proof is not complete: some case has not been examined, a significant step has not been justified, or an unspoken assumption has been made. Some parts of the argument are not clearly explained. The organization makes it difficult to discern the structure of the argument.
5 **Not Meeting Expectations**	The statement of the problem is missing or unclear. Grammar and/or spelling errors distract from the content. The formatting does not meet the submission guideline.	Some variables are used without being introduced. Some symbols are used inappropriately, or some terminology is used incorrectly. The proof is not written in prose form.	The logical reasoning has a serious flaw or multiple minor flaws. Significant revision is required to correct the argument. The proof is not complete: some case has not been examined, a significant step has not been justified, or an unspoken assumption has been made. Some parts of the argument are not clearly explained. The proof is not well organized.
0 **No Submission**	No solution is submitted, or the solution does not make progress on the assigned problem.		

Grade Combining Rubric

Overall Grade	Requirements
GM	Grades satisfy all the following requirements: • At least 50% of homework grades at level GM, and at least two major assignment grades are GM; or all major assignment grades are GM • There are no more than two PM homework grades • There are no PM grades on major assignments • There are no NE or NS grades
UM	Grades satisfy all the following requirements: • At least 50% of homework grades are at level UM or higher, and at least two major assignment grades are UM or higher; or all major assignment grades are UM or higher • There are no more than two NE homework grades • There are no NE grades on major assignments • There are no NS grades • Note: There may be some GM grades, but the overall standard for GM is not met
PM	Grades satisfy all the following requirements: • At least 50% of homework grades are at level PM or higher, and at least two major assignment grades are PM or higher • There are no NS grades on major assignments • There are no more than two NS grades on homework • Note: There may be some grades higher than PM, but the grades do not meet the overall standard for GM or UM
NE	Grades satisfy all the following requirements: • The grades do not meet the standard for GM, UM, or PM • There are no NS grades on major assignments • There are not more than two NS grades on homework
NS	The grades do not meet the overall standard for GM, UM, PM, or NE