

Mathematics 203 – 004; Linear Algebra; Spring 2020 (CRN [12575](#))

Class Schedule: Tue & Thu: 7:20 – 8:35 PM	Location: David King Hall Room 1006
Class Dates: Tue 21 Jan – Thu 30 Apr	Final exam: TUE 12 MAY 7:30-10:15 PM (in classroom)
Instructor: Mr. Glenn Preston	Email: gpresto3@gmu.edu
Office: Exploratory Hall, Room 4309	Office Hours: Tue & Thu 4:30 – 6:30 PM and by appt.

PREREQUISITES:

- Grade of C or higher in Math 114, 114T, or 116 → In addition you will need to have a **SOLID** foundation in geometry, **algebra**, functions in the xy-plane, and be proficient in basic arithmetic
- It is useful to have taken (or be taking) Calc III (213) and/or Differential Equations (214) but that is NOT required. I will occasionally reference the connection between our course topics and those courses (particularly 213), but that will be for your information and insight only, and will **not** be required knowledge for this course.

REQUIRED TEXTBOOK AND OTHER MATERIALS:

- **Linear Algebra and Its Applications**, by Lay, Lay, McDonald; 5th Edition; Pearson, 2016, ISBN: [9780321982384](#)
- **Authors' Study Guide (OPTIONAL)**: A few of the answers in the back of the book are incomplete and refer you to the study guide for details ☺. **However, I have posted comprehensive solutions to all homework problems.** ☺
- **OPTIONAL** and **FREE** ☺: You will find using a computer helpful to AUGMENT your by-hand work (**not** replace doing problems by hand). I like Old Dominion University's [Linear Algebra Tool-kit](#) and I am sure there are others. Mathematica (**FREE**) may also be helpful although it is a general purpose CAS program and not Linear Algebra specific.

COURSE LEARNING OBJECTIVES:

- **GMU Catalog:** "Systems of linear equations, linear independence, linear transformations, inverse of a matrix, determinants, vector spaces, eigenvalues, eigenvectors, and orthogonalization."
- **Glenn's Additional Objectives:** Prepare you to be successful in future math, physics, science, engineering, computer, and other courses; enhance your problem solving skills, intuition, and insight. Also, help you to be an effective and valued employee in your career field someday.

Major points of emphasis will be to cultivate your skills to:

- (1) Obtain a solid understanding of the concepts/theory of the course, master the problem solving techniques, and execute correct and well organized/well documented solutions to problems
 - (2) Analyze problems and solutions to understand what they mean, how they behave, determine the proper analytical technique(s), and when/where they are valid to keep out of trouble by not incorrectly applying them
 - (3) Do a "sanity check" to see if your answer makes sense – e.g. does it have the correct properties? Does it fall within reasonable upper and/or lower bounds based on a "ball park" estimate or limiting case?
 - (4) Self-reliance, BUT also knowing when/how to ask for help. **I HIGHLY ENCOURAGE QUESTIONS.** However, before asking a question you should "do your homework" first – literally and figuratively. **Come PREPARED.**
- **Many students have difficulty solving problems due to one or more of the following issues:**
 - They don't **diagnose the problem** and develop a **strategy BEFORE** they start and go down the wrong path
 - They don't take an **organized approach** to problem solving. You should: organize the information, determine what is known and what is unknown, write down the fundamental equation(s) that govern the problem, draw a picture/diagram or make a table to help visualize the problem and solution
 - They make fundamental algebra and other errors, and/or they don't check their work (**CYFA!**).

COURSE APPROACH: WE WILL EMPHASIZE THE FUNDAMENTALS

- (1) Learn how to **diagnose** and "**attack**" problems to **determine the problem type**, underlying **concept(s)**, appropriate problem solving **technique(s)**, and to master the **mechanics** of executing the solution
- (2) **Proofs and/or derivations of key theorems and techniques** – these are essential for learning and **understanding the "5Ws"** (i.e. the "**who, what, when, where, why, and how**") which is **crucial** to **really** learning the material.
- (3) Include **fundamental concepts and techniques from prerequisite courses** to ensure that you have and maintain a solid foundation. I will also discuss how concepts in this course apply to prior and potential future courses to put them in proper context. This is intended to help you understand THIS course and NOT to include additional required topics that are outside the scope of this course.

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HOMWORK EXERCISES:

- WORD TO THE WISE:** **If you don't do a thorough and comprehensive job on the homework exercises, you will almost certainly fail the course – it is that simple.** Many have tried to short-change the homework process, myself included, and it always ends VERY badly.

GRADES: COURSE AVERAGE COMPUTATION AND GRADE SCALE

Graded Item	Nominal	Max Final	Max Midterm
Midterm Exams	60% (All 3)	40% (Best 2)	70% (All 3)
Comprehensive Final Exam	40%	60%	30%
EXTRA CREDIT: "Pop quizzes"	5%	5%	5%
TOTAL	105%	105%	105%

- A course average will be calculated for each student using all three weightings. For each student, on an individual basis, **I will use your HIGHEST average to determine the overall course grade using the grading scale below.**

F (0.0)	D (1.0)	C- (1.67)	C (2.0)	C+ (2.33)	B- (2.67)	B (3.0)	B+ (3.33)	A- (3.67)	A (4.0)	A+ (4.0)	Letter Grade (Grade Points)
< 60	≥ 60	≥ 70	≥ 72	≥ 78	≥ 80	≥ 82	≥ 88	≥ 90	≥ 92	≥ 100	Course Average

- Grades are based on an absolute 100-point scale and NOT using a "curve".** Your performance will be evaluated relative to what you need to achieve in order to be successful in future courses rather than relative to your classmates' performance (i.e. a curve). Exams will be designed accordingly and **you will have opportunities to earn extra credit on the pop quizzes and exams will have ≥ 10% extra credit built-in (i.e. 110 or more points).**
- Speaking of Extra Credit: There are no extra credit assignments or other additional work during or at the end of the semester that can be done to boost your grade.** I still get asked every semester – and the answer is still "no". The time to be diligent is **NOW**, not in desperation at the end of the semester.

EXAM POLICIES:

- MAKEUP MIDTERM EXAMS AND QUIZZES: NONE EXCEPT CONSISTENT WITH GMU POLICY AS STATED BELOW**
 - There will be **no makeup exams or quizzes** except as described below. Missed exams/quizzes will receive a 0.
 - Per **GMU Academic Policy A.P.1.6.1**, you may be able to take a midterm exam at an alternate time **WITH PRIOR ARRANGEMENT**. This applies only to situations involving:
 - Religious Observance** - I have done my best to de-conflict the course schedule with religious holidays. However, if the schedule changes or there is a situation/conflict I am not aware of, please let me know.
 - Mandatory Participation in Official University Activities** (e.g. intercollegiate athletics, GMU band)
 - If you have a conflict, please let me know ASAP. **Last minute requests (< 48 hours) will not be considered regardless of circumstances.** Planning ahead is an important survival skill in the "real world".
 - If you have **truly extraordinary circumstances** that aren't covered by the GMU policy above, please see me. I'll listen but it needs to be a **VERY** good reason in order to arrange for a make-up exam (*but no pop quiz make-ups*).
- COMPREHENSIVE FINAL EXAM:**
 - IMPORTANT NOTE:** Per GMU Policy [A.P.3.10](#), you **must** take the final exam at the regularly scheduled date and time unless you have **excused absence in writing signed by your Dean or Academic Director**.
 - GMU policy allows you to arrange an alternate day/time if you have a direct conflict between final exams or more than two final exams on one day. If so, **let me know at least one week prior to the final exam.**
- OTHER EXAM INFORMATION:**
 - NO NOTES OR REFERENCES OTHER THAN THE ONES I PROVIDE:** For each exam I will provide reference sheet(s) with some formulas and other information as I deem appropriate. However, I expect you to know and/or be able to derive from basic principles most/all of what you need to know to solve problems. I will let you know prior to the exam what reference material/formulas/theorems will be provided.
 - YOU MAY USE ANY CALCULATOR OF YOUR CHOICE DURING EXAMS (BUT NOT A CELL PHONE). NO OTHER ELECTRONIC DEVICES ARE ALLOWED** (Put them away and turn them **OFF**). Some of our problems can be very arithmetic-intensive so you can use a calculator to assist in that process. However, the calculator is intended to help you avoid/reduce arithmetic errors and **not to be the primary way you solve problems**. A calculator is a

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TOOL and you should always know how to do things by hand when using tools/technology.

AS A RESULT, YOU WILL NEED TO BE VERY EXPLICIT AND CLEARLY SHOW ENOUGH STEPS IN YOUR SOLUTION TO DEMONSTRATE THAT YOU:

- (1) Understand the problem and associated basic concepts
- (2) Know the appropriate problem solving technique(s) for the problem and how to do them
- (3) Can properly execute the required steps, not simply plug numbers into a calculator and hope that it produces the correct answer. **(Calculators are fine to check matrix operations but not to derive them)**

BOTTOM LINE: If you show NO/VERY LITTLE WORK → you will receive NO/VERY LITTLE CREDIT

WHAT TO EXPECT ON MIDTERM EXAMS AND POP QUIZZES:

- On **all** exams and quizzes, regardless of topic, I will be looking for you to demonstrate:
 - 1) **A well-organized solution with a logical and mathematically correct progression from each step to the next**
 - **SHOW YOUR WORK**; don't leave large gaps between steps, be careful with use of an equal sign → both sides must truly be equal or else it is an incorrect statement; ensure proper use of notation
 - **WHAT YOU WRITE DOWN MATTERS** - even if you understand what you are doing, you need to properly communicate that understanding to me (and later to coworkers, customers, your boss, etc.)
 - 2) **Good problem solving skills**: The ability to **DIAGNOSE** a problem to determine the type of problem, recognize and understand the **FUNDAMENTAL CONCEPT(S) INVOLVED**, determine and properly apply the **APPROPRIATE PROBLEM SOLVING TECHNIQUE(S)**, and correctly **EXECUTE THE MECHANICS** technique(s)
 - 3) **Correct analysis, understanding, and interpretation of the solution**: **For example**:
 - Analyzing the properties/behavior of a solution to understand what it means, seeing if the solution passes a "sanity check" and/or estimating upper and/or lower bounds for the answer
 - Does the solution match given conditions and/or satisfy physical constraints of the problem?
 - Is the solution defined over the appropriate domain and does it produce the appropriate range?
 - Proper geometric interpretation of a problem and its solution; describe/sketch the solution when possible.

WHAT TO EXPECT ON THE COMPREHENSIVE FINAL EXAM:

- The **emphasis will be on key concepts/techniques**, particularly putting them together to solve "compound" problems, applications, and understanding of the "big picture" and "the 5W's"

HONOR CODE: THIS IS VERY IMPORTANT

- **It is expected that each student in this class will conduct himself or herself within the guidelines of the Honor Code.** Among other things, this means that sharing information of any kind about exams (either before or during the exam) is forbidden as well as use of prohibited material or devices. Any alleged issues related to the honor code will be brought to the attention of the Office of Academic Integrity. Please read the [University Honor Code](#) and abide by it.

GETTING HELP:

- **Don't let a small problem turn into a big one by getting behind – it will be very difficult to catch up.**
 - **Contact me** via email and/or come see me during regular office hours or make an appointment.
 - **The Math Tutoring Center**, Johnson Center, Room 344: <http://math.gmu.edu/tutor-center.php>
 - **Internet Resources**: There are tons of good stuff (and lots of crap too so be careful of your sources); here are a few I like, just be aware of possible differences in notation from our textbook
 - **3Blue1Brown Series (Videos)**: [The Essence of Linear Algebra](#); **THESE ARE EXCELLENT**
 - **The Kahn Academy Tutorials**: [Linear Algebra Home Page](#)
 - **Open Courseware (OCW)**: Over 240 institutions participate in the [Open Education Consortium](#), many of which are top universities such as [MIT](#) (MIT has a very extensive set of materials, videos, etc.)
 - **Wolfram Mathematica Demos**: [Linear Algebra Examples](#), [Matrices and Linear Algebra](#)

CLASS WEB PAGE/COMMUNICATION:

- I will post all class materials, announcements, scores/grades on **Blackboard** and send some things via GMU email.
- **The primary way to contact me is via GMU email (gpresto3@gmu.edu)**

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- To comply with GMU policy and protect your privacy, I will only send email from my GMU account and try to only send email to your GMU email address. **Please only send email to me from your GMU email so I can use the “reply” function in responding to you.**
- I will try to reply to each email ASAP and within 24 hours if at all possible. Please bear in mind that just like you, I “have a life” which may occasionally delay my response. As an alternate means of contact/last resort in case of **emergency** you can **text** me at (703) 405-0344 (text only please, I don’t answer calls from unknown numbers)

OTHER TOPICS:

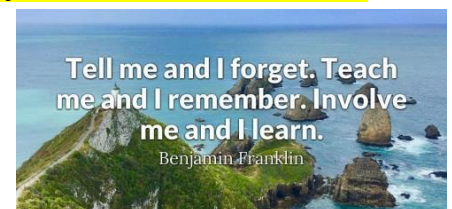
- **Class Schedule:** The last page shows the nominal schedule for lecture topics, exams, homework, etc. (“pop quizzes” are unscheduled and may occur at any time (generally the last 10 – 15 minutes of a class period). Modifications to the schedule will almost certainly be required due to weather and a variety of other factors. **You are responsible for being aware of any announced, emailed, and/or posted changes to the schedule.**
- **Syllabus: Yea, this thing. Please read it (RTFS) and please check the syllabus before asking questions that can be easily answered on your own.** **QUESTIONS ARE ENCOURAGED**, however, when you get a job if you ask lots of questions that you could have/should have answered on your own, pretty soon your boss and colleagues will wonder what value you are adding to the team, and you will get the crap work, be slow to advance, and possibly be fired.
- **Attendance: Will not be taken and there is no “participation” component to your grade.** It is your choice/responsibility to show up for class, be prepared, and get something out of it. **REGARDLESS OF WHETHER YOU ATTEND CLASS REGULARLY OR NOT, IT IS VITAL THAT YOU KEEP PACE WITH THE COURSE SCHEDULE.**
- **Electronic Devices and Other Disturbances:** Please be courteous and silence all cell phones, pagers, iPods, and other devices during class (they should be **OFF** during exams). You may use a laptop, smartphone, or other electronic device for capturing notes or other legitimate class-related use (but **NOT** during an exam). **Also, if you wish to chat during class that’s fine, just go somewhere else and don’t disturb others who are here to learn.** **BOTTOM LINE:** Please use common sense and avoid disrupting the class and/or distracting other students.
- **University Policies:** Please familiarize yourself with university policies. The University Catalog, <http://catalog.gmu.edu>, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. All members of the university community are responsible for knowing and following established policies and procedures. (See also <http://universitypolicy.gmu.edu/>)

OTHER UNIVERSITY RESOURCES AND LINKS:

- **Mathematical Sciences Department:** Exploratory Hall room 4400, (703) 993-1460
- **Office of Disability Services** (ODS): Student Union Building I, Room 211, (703) 993-2474. All academic accommodations must be arranged through ODS. If you are a student with a disability and need academic accommodations, please contact ODS as soon as possible and do not hesitate to speak confidentially with me.
- **Counseling And Psychological Services** (CAPS): Student Union Building I, Rm 3129, (703) 993-2380
- **Veterans: Office of Military Services:** SUB I, Suite 1510 (next to Chik-Fil-A) , (703) 993-1316

MY COMMITMENT TO YOU:

- So far all of the rules have been imposed on you. However, you have a right to expect certain things from me as well. I have responsibilities to each student and to the class as a whole. My commitment to the class is that I will:
 - Do my best to follow my own advice/rules and lead by example – i.e. I will try to **“practice what I preach”**
 - Be as honest, open, and transparent as possible in how I conduct the class, consistent with maintaining proper student privacy/confidentiality and the academic integrity of the course.
 - Treat every student with respect and as an individual having individual talents and needs, within the constraints of doing what is best for the class as a whole.
- **Bottom Line: To be successful in this course you will need to do more than just the bare minimum → I am ready, willing, and able to do more than the minimum required of me**
 - I will hold extra office hours, review sessions prior to exams, provide “chapter notes”, detailed homework solutions, and other supplemental material – whatever I can legitimately do to help students realize their potential.
 - But bear in mind: **You learn by doing** and I can’t “do the doing” for you.



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*** Class Lecture/Exam/Homework Schedule (Subject to Change) ***

Unless there are class cancellations we will stick to this schedule. Exams will cover scheduled sections regardless of how much of any particular chapter section we cover during each lecture.

Prior to Each Class:

- **GOOD:** Make sure you have completed homework from all prior chapter sections. Seek help as needed.
- **BETTER:** Read upcoming section(s). WORK THROUGH THE EXAMPLES IN THE TEXT PRIOR TO CLASS
- **BEST:** Try the homework for the upcoming section(s): Do what you can, make a list of questions for the rest.

Course Schedule

WK	TUE	THU
1	21 JAN	23 JAN
	Intro, 1.1	1.2, 1.3
2	28 JAN	30 JAN
	1.3, 1.4	1.5, 1.7
3	4 FEB	6 FEB
	1.7, 1.8	1.9
4	11 FEB	13 FEB
	Catch-Up/Review	EXAM-1 Ch. 1
5	18 FEB	20 FEB
	2.1, 2.2	2.2, 2.3
6	25 FEB	27 FEB
	2.8, 2.9	2.9, 3.1
7	3 MAR	5 MAR
	3.1, 3.2	3.2, 3.3
8	10 MAR	12 MAR
	SPRING BREAK – NO CLASS	
9	17 MAR	19 MAR
	Catch-Up/Review	EXAM-2 Ch. 2 & 3
10	24 MAR	26 MAR
	4.1, 4.2	4.2, 4.3
11	31 MAR	2 APR
	4.4, 4.5	4.5, 4.6
12	7 APR	9 APR
	4.7, 5.1	5.1, 5.2
13	14 APR	16 APR
	Catch-Up/Review	EXAM-3 Ch. 4, 5.1, 5.2
14	21 APR	23 APR
	5.3, 5.4	5.4, 5.5
15	28 APR	30 APR
	5.7, 6.1	Catch-Up/Review
Snow Makeup Day TBD (if needed)		
COMPREHENSIVE Final Exam TUE 12 MAY 7:30 – 10:15 PM David King Hall Room 1006		

Homework Exercises (x – y = ODD ONLY)

Ch	Chapter / Section Title	Exercises
1: Linear Equations in Linear Algebra (Exam 1)		
1.1	Systems of Linear Equations	1 – 19, 23, 27
1.2	Row Reduction and Echelon Form	1, 3, 7 – 13, 19, 21
1.3	Vector Equations	1 – 5, 9 – 13, 17, 23
1.4	The Matrix Equation $Ax = b$	1 – 23, 33
1.5	Solution Sets of Linear Systems	1 – 23
1.7	Linear Independence	1 – 11, 15 – 21, 31
1.8	Introduction to Linear Transformations	1 – 21
1.9	The Matrix of a Linear Transformation	1, 3, 9, 15 – 27
2: Matrix Algebra (Exam 2)		
2.1	Matrix Operations	1 – 11, 15, 17, 27
2.2	The Inverse of a Matrix	1 – 9, 29 – 35
2.3	Characterization of Invertible Matrices	1 – 7, 11, 15, 17, 33
2.8	Subspaces of \mathbb{R}^n	1 – 11, 15 – 25
2.9	Dimension and Rank	1 – 5, 9 – 17
3: Determinants (Exam 2)		
3.1	Introduction to Determinants	1 – 23, 39
3.2	Properties of Determinants	1 – 15, 19 – 25, 27 (c & d)
3.3	Cramer's Rule, Volume, & Linear Trans.	1, 3, 15, 19 – 23, 27
4: Vector Spaces (Exam 3)		
4.1	Vector Spaces and Subspaces	1 – 17, 23
4.2	Null Spaces, Column Spaces, and Linear Trans.	1 – 27
4.3	Linearly Independent Sets; Bases	1 – 15, 21
4.4	Coordinate Systems	1 – 15
4.5	The Dimension of a Vector Space	1 – 21, 27, 29
4.6	Rank	1 – 17
4.7	Change of Basis	1 – 11
5: Eigenvalues and Eigenvectors (Exam 3)		
5.1	Eigenvalues and Eigenvectors	1 – 17, 21
5.2	The Characteristic Equation	1 – 17, 21
5: Eigenvalues and Eigenvectors Cont'd. (On Final Exam)		
5.3	Diagonalization	1 – 13, 17, 21
5.4	Eigenvectors and Linear Transformations	1 – 13, 17
5.5	Complex Eigenvalues	1 – 9, 13, 15, 21
5.7	Applications to Differential Equations	1 – 13
6: Orthogonality and Least Squares (On Final Exam)		
6.1	Inner Product, Length, Orthogonality	1 – 17, 23

KEY DATES TO REMEMBER: These dates are provided as a courtesy/convenience, check the Registrar's webpage for official information: <https://registrar.gmu.edu/calendars/spring-2020/>

- **Drop dates:** WED 5 Feb (100% refund); TUE 11 Feb (50% refund)
- **Unrestricted Withdrawal (0% refund):** WED 12 Feb – MON 24 Feb
- **Selective Withdrawal:** TUE 25 Feb – MON 30 Mar