Mathematics 203 – 004; Linear Algebra; Fall 2019

Class Schedule:	**Tue & Thu: 8:45 – 10:00 PM**	**Location:**	**Enterprise Hall Room 178**
Class Dates:	**Tue 27 Aug – Thu 5 Dec**	**Final exam:**	**THU 12 DEC 7:30-10:15 PM *(in classroom)***
Instructor:	**Mr. Glenn Preston**	**Email:**	**gpresto3@gmu.edu**
Office:	**Exploratory Hall, Room 4309**	**Office Hours:**	**Tue & Thu 6:30 – 8:30 PM and by appt.**

Prerequisites:

- Grade of C or higher in Math 114, 114T, or 116 ➔ In addition to a very good understanding of single-variable calculus, **you will need to have a SOLID foundation in basic geometry, algebra, trig, and other pre-calc topics.**
- 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, but that will be for 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**
- **Study Guide (OPTIONAL):** This is not required. However, you may find it helpful, and if it helps you achieve a better understanding of the material and/or not have to repeat the course it is probably a good investment. Also, some of the answers in the back of the book are incomplete and refer you to the study guide for details.
- **OPTIONAL** and **FREE** ☺: You will likely find using a computer helpful to AUGMENT your by-hand work (**not** replace doing problems by hand). I like the Linear Algebra Tool-kit posted by Old Dominion University http://www.math.odu.edu/~bogacki/cgi-bin/lat.cgi , 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 like ODU's.

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, and when/how they are valid to keep out of trouble when a solution (or technique) is not valid

  (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?

  - **Many students fall down in solving problems due to one or more of the following issues:**
    - They don't **diagnose the problem** and develop a **strategy** BEFORE they dive in
    - They don't take an **organized approach** to problem solving ➔ 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 in geometry, algebra, trigonometry, functions, and single-variable calculus. I will also discuss how concepts in this course apply to prior and potential future courses to put them in proper context.

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Grades: Course Average Computation and Grade Scale

GRADED ITEM	Nominal	Max Final	Max Mid-term
Mid-term Exams	**60%** *(All 3 @ 20% each)*	**40%** *(best 2 @ 20% each)*	**75%** *(all 3 @ 25% each)*
Comprehensive Final Exam	**40%**	**60%**	**25%**
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 exams and with pop quizzes.**
- **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 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 mid-term exam at an alternate time **WITH PRIOR ARRANGEMENT**. This applies only to situations involving:

    (1) 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.

    (2) 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 (*no quiz make-ups*).
- **OTHER EXAM INFORMATION:**
  - **NO NOTES OR REFERENCES:** All exams will be closed book and no notes or other reference material of any kind will be allowed. 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, if any, reference material/formulas will be provided.
  - YOU MAY USE ANY CALCULATOR OF YOUR CHOICE (**BUT NO CELL PHONES**) DURING EXAMS BUT 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 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.

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Mid-term Exams:

- **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?
     - Estimate "ball park" values using simpler conditions (e.g. round numbers, simpler curves/shapes)
     - Proper geometric interpretation of a problem and solution; describe/sketch the solution when possible.

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"
  - **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 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.**

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 reread the University Honor Code and abide by it.

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. Everyone learns a little differently and some students need more help than others – I am prepared to work with you in whatever way works best for you.
  - **Bottom line:** To be successful in this course you will need to do more than just the bare minimum ➔ I am therefore ready, willing, and able to do more than the minimum required of me *(e.g. extra office hours, review sessions, provide supplemental material, whatever I can do to help students realize their potential)*

Homework 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 (myself included) to short-change the homework process and it always ends VERY badly.**

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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
    - **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)**
  - 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, you can text me at (703) 405-0344 (but please don't flood me with texts) and in an **emergency**, you can call that number.

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 be slow to advance and possibly get laid-off/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: 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).
  Basic principle: 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

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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	27 AUG	29 AUG
	Intro, 1.1	1.1, 1.2
2	3 SEP	5 SEP
	1.3, 1.4	1.4, 1.5
3	10 SEP	12 SEP
	1.7, 1.8	1.8, 1.9
4	17 SEP	19 SEP
	REVIEW	EXAM-1 Ch. 1
5	24 SEP	26 SEP
	2.1, 2.2	2.2, 2.3
6	1 OCT	3 OCT
	2.8, 2.9	2.9
7	8 OCT	10 OCT
	3.1, 3.2	3.2, 3.3, REVIEW
8	15 OCT	17 OCT
	NO CLASS	EXAM-2 Ch. 2 & 3
9	22 OCT	24 OCT
	4.1, 4.2	4.2, 4.3
10	29 OCT	31 OCT
	4.4, 4.5	4.5, 4.6
11	5 NOV	7 NOV
	4.7, 5.1	5.1, 5.2
12	12 NOV	15 NOV
	REVIEW	EXAM-3 Ch. 4, 5.1, 5.2
13	19 NOV	21 NOV
	5.3, 5.4	NO CLASS
14	26 NOV	28 NOV
	5.4, 5.5	5.7, 6.1
15	3 DEC	5 DEC
	6.1, 6.2	Catch-up/Review
Snow Makeup Day TBD (if needed)		
COMPREHENSIVE Final Exam THU 12 DEC 7:30 – 10:15 PM Enterprise Hall Room 178		

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, 27
1.2	Row Reduction and Echelon Form	1, 3, 7 – 13, 19
1.3	Vector Equations	1 – 5, 9 – 13, 17
1.4	The Matrix Equation A**x** = **b**	1 – 21, 33
1.5	Solution Sets of Linear Systems	1 – 21
1.7	Linear Independence	1 – 11, 15 – 19, 31
1.8	Introduction to Linear Transformations	1 – 19
1.9	The Matrix of a Linear Transformation	1, 3, 9, 15 – 27
	2: Matrix Algebra (Exam 2)	
2.1	Matrix Operations	1 – 11, 17, 27
2.2	The Inverse of a Matrix	1 – 5, 7, 29 – 35
2.3	Characterization of Invertible Matrices	1 – 7, 11, 15, 17, 33
2.8	Subspaces of $\mathbb{R}^n$	1 -11, 15 – 19, 23, 25
2.9	Dimension and Rank	1 – 5, 9 – 15
	3: Determinants (Exam 2)	
3.1	Introduction to Determinants	1 – 13, 19 – 23
3.2	Properties of Determinants	1 – 15, 19 – 25
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
4.2	Null Spaces, Column Spaces, and Linear Trans.	1 – 27
4.3	Linearly Independent Sets; Bases	1 – 15
4.4	Coordinate Systems	1 – 13
4.5	The Dimension of a Vector Space	1 – 17, 21, 27, 29
4.6	Rank	1 – 17
4.7	Change of Basis	1 – 9
	5: Eigenvalues and Eigenvectors (Exam 3)	
5.1	Eigenvalues and Eigenvectors	1 – 17
5.2	The Characteristic Equation	1 – 17
	5: Eigenvalues and Eigenvectors Cont'd. (On Final Exam)	
5.3	Diagonalization	1 – 17
5.4	Eigenvectors and Linear Transformations	1 – 13, 17
5.5	Complex Eigenvalues	1 – 17, 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
6.2	Orthogonal Sets	1 – 21