BOB JONES UNIVERSITY
Department of Mathematics

# Ma 311 ~ Linear Algebra

*Fall Semester 2025-26*

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| Professor: | Dr. Laurel Carpenter, llcarpen@bju.edu |
| Office: | Al 46 |
| Office Hours: | Daily by appointment, `https://calendly.com/llcarpen` |
| Preferred Contact: | MS Teams or email |
| Textbooks: | *Elementary Linear Algebra*, 8e, by Larson |
| Technology: | TI 89 or NSpire CAS |
| Course Website: | `http://math.bju.edu/ma135/` |

## Course Description

Vector, vector functions, linear functions, solutions of systems of linear equations, matrices, determinants, and eigenvalues.

Prerequisite: Ma 135

## Course Context

This course supports the following objectives of the mathematics and actuarial program:

- MM1: Progress logically from premises to valid conclusions in a variety of mathematical contexts.
- MM2: Apply mathematics to model real-life situations.
- MM3: Select and use technology for understanding, as well as a labor-saving or problem-solving tool.

## Course Goals

The student will . . .

- CG1: Develop competency at applying linear systems and matrix solution techniques in a variety of contexts including engineering, computing, and the natural sciences.
- CG2: Build a foundation in vector and matrix theory that supports related areas such as analysis and differential equations, operations research, modern geometry, stochastics, cryptography, and graph theory
- CG3: Be introduce to the field of abstract algebra including important concepts in vector spaces and linear transformations.
- CG4: Sharpen critical-, analytical-, and creative-thinking while applying abstract ideas to scenarios in the natural world.
- CG5: Develop concise use of language and logical thought in proving algebraic properties and theorems.
- CG6: Develop instructor-independence for learning new mathematical concepts, approaches, and applications.
- CG7: Develop skills necessary to communicate mathematical concepts clearly to various audiences both orally as well as in writing.

## Course Objectives

The student will be able to ...

1. Reduce a matrix to an REF or the RREF either by hand or using technology. CG1/3/5 (Assessed by Tests)
2. Use matrices (by conversion to RREF) to solve linear systems. CG3/4 (Assessed by Tests)
3. Apply linear systems to problems such as curve fitting, network analysis, and chemical reactions. CG2/4/5 (Assessed by Projects)
4. Perform matrix operations including matrix addition, matrix multiplication, scalar-matrix multiplication, and transposition. CG1/3/5 (Assessed by Tests)
5. Identify the algebraic properties of matrices. CG1/3/5/7 (Assessed by Tests)
6. Factor matrices (when applicable) into elementary matrices and/or into LU form. CG1-5 (Assessed by Tests)
7. Apply matrices in applications such as stochastics, cryptography, and Leontief input-output models. CG2/4/5 (Assessed by Projects)
8. Construct cofactors and calculate determinants of matrices both by hand and using technology CG1/3/5 (Assessed by Tests)
9. Construct inverse matrices both by hand (using elementary matrices, using adjoints) and using technology. CG1/2 (Assessed by Tests)
10. Identify when a square matrix is invertible (using the Equivalent Conditions for a Nonsingular Matrix). CG1-7 (Assessed by Tests)
11. Apply determinants to problems of area and volume in real n-space. CG1/2/4 (Assessed by Tests and Projects)
12. Determine if a given structure is a vector space, a subspace of a vector space, and/or an inner-product space. CG1/3/5 (Assessed by Tests)
13. Determine if a given set of vectors is linearly independent, a spanning set, and/or a basis. CG1/3/5/7 (Assessed by Tests)
14. Define bases (and calculate dimensions) for the row-space (rank), column-space, and null-space (nullity) of a matrix and articulate the principle of duality. CG1/3/5/7 (Assessed by Tests)
15. Determine coordinate and transition matrices in real n-space. CG1-7 (Assessed by Tests)
16. Calculate (in an inner-product space) the norm of a vector, the distance between vectors, and the angle between vectors. CG1-7 (Assessed by Tests)
17. Construct orthogonal projections and orthonormal basis for a given basis in an inner product space using the Gram- Schmidt process. CG1-7 (Assessed by Tests)
18. Construct a Fourier approximation to a polynomial. CG1-7 (Assessed by Tests)
19. Identify when a relation is a linear transformation and if the linear transformation is 1-1 and/or onto.. CG1-7 (Assessed by Tests)

20. Determine bases for the kernal, domain, and range of a linear transformation. CG1-7 (Assessed by Tests)
21. Represent a linear transformation as a matrix. CG1-7 (Assessed by Tests)
22. Determine if two matrices represent the same linear transformation. CG1-7 (Assessed by Tests)
23. Determine (and interpret) eigenvectors and associated eigenvalues of linear transformations. CG1-7 (Assessed by Tests)

## Course Requirements

The course grade will consist of ...

- Unit Tests: Approximately four unit tests as announced in class. Chapter tests will be worth between 75 to 100 points each.**
  Tentative Test Dates: Dates may shift depending on when material is finished in class. To better anticipate test dates, note the number of sections remaining in the chapter. See Canvas for current schedule.
  Ch 1-3 Sept 15, Ch 4 Oct 13, Ch 5 Nov 3, Ch 6-7 Dec 3
- Final Exam: A cumulative final exam worth 160 points will be given at the time assigned by the University.**
- Projects: Approximately four projects are to be worked outside of class as assigned. These sets are to be the student's own work (without unauthorized collaboration or help). Each project will be worth 25 points.**
- Exercise Sets: Exercise sets worth 5 points per unit are due in class on the day of the corresponding unit test.
- Other Assignments: Other assignments/quizzes as announced in class. Spontaneous (unannounced) quizzes may occur in class.

** Point assignments are subject to change.

## Course Evaluation

All course/assignment grades are based on the evaluation of the work communicated by the student. Unclear or incomplete communication of the solutions, which includes the process, may result in a penalty at the professor's discretion.

Letter grades will be based on a standard 10-point scale

## Office Hours

Office appointments can be made using the Calendly site (appointments may be made up to two weeks in advance), `https://calendly.com/llcarpen`. If there are no available times at which you are able to meet, send your professor a message including some days/times between 7:30am and 3pm when you are available.

## General Policies

### Deportment

Compliance with student handbook policies is expected during class. The classroom is to be a professional environment. That means you are to come to class prepared for the day's discussion, your attention is expected to be on course related material, and you are expected to positively contribute to the class.

### Emergencies During Class

In case of emergency requiring evacuation, students will go down the stairs on the fountain side and exit the door facing Wade Hampton underneath the stairs. Students will immediately cross the street and gather by the fence with their class. If we are unable to exit the building, the professor will instruct the students on the best course of action. To be able to respond quickly to external threats, professors may keep classroom doors locked. If you are late arriving to class, you may need to knock on the door and be let in.

### Absences

BJU attendance policy is in effect (see `https://home.bju.edu/bju-policies/` for details).

- Scheduled tests/quizzes should be taken before your planned absence; please contact your professor to make arrangements for doing so. You are personally responsible for getting notes from your classmates and discussing the missed material with them. You should not expect your professor to privately re-teach you the material you missed. Your professor is always available to help you with specific questions. If an unannounced quiz/assessment is taken during the class that you miss, you will NOT be allowed to make it up, and you WILL receive a zero on the assignment. Work may always be completed early (see your professor if you wish to take a test early).
- Missing an in-class test because you feel you are not prepared to take it is not acceptable. Work missed for this reason will not be made up and you will receive a zero on the assignment.
- For absences due to incapacitating illness or emergency, you should contact the instructor as soon as you realize you will not be in class to make arrangements to make up any missed work. Tests will be made up without penalty for the first occurrence. Each subsequent time a test is missed because of incapacitating illness or emergency, an additional 10% grade penalty for that test will be incurred. A 10% penalty will be assessed for a late submission of take-home tests. All late work must be made up by the next class period unless other arrangements have been made with the professor.

### Presentation of Work

The goal is professional, fluent, and clear communication of what you know.

PW 1: Proper use of mathematical notation is expected. The structure of notation conveys specific meaning and should be used appropriately.

PW 2: Mathematical presentation is like grammar. There are subjects, verbs ($=, \leq, >$, etc.), and objects. Always write in "complete sentences."

PW 3: Tests/presentations/projects are not about what you know, but about what you can communicate about what you know – so the presentation of your work/logic should always be neat, orderly, clearly defined, and with the appropriate amount of supporting detail. (Excessive steps are not required; however, answers alone are not (usually) acceptable.)

PW 4: Always work down the page. (Working in multiple columns is generally not acceptable.) There should be one problem worked in each "row" because this contributes to clarity and the development of your logical argument.

PW 5: Skip lines between problems. If you have dense handwriting, skip every other line and skip 2-3 lines between problems.

PW 6: Clearly label problems/sub-problems. Problems do not necessarily have to be worked in order but must be clearly labeled either way. Your professor will communicate their expectation on presenting problems out of order.

PW 7: Answers are to be presented as the logical conclusion of your work, not as the only important thing (e.g. at the start of the problem and/or unconnected with any justifying work).

PW 8: Work should be submitted on clean $8.5 \times 11$ inch (standard-size) paper and should not be submitted with "spiral"/ripped edges.

PW 9: Take-home tests (when time is not limited) should be neatly presented (rewritten, organized, no scratchwork, etc.) as a final polished piece.

Your professor may refuse to accept work that does not meet the minimum presentation requirements above, or they may choose to deduct up to 10% from the assignment.

Problems Expectations

The goal is to prove your mastery (not your just barely comprehending).

PE 1: Read all words carefully in a question. Everything is important, so know what the meanings of all words are and how those words tell you to respond.

PE 2: Theory is a precise expression of important ideas. While it is not graded word for word, jot for jot, the precise ideas must be maintained. Embrace thorough, smooth learning and presentation. Can you recite the theory from the last class period quickly, comfortably, and conversationally?

PE 3: Theory tells us how to solve problems. Know exactly what problems connected to each theorem or definition look like, and know how to solve them.

PE 4: Know what the key steps of each problem are. Present only the key steps (or the minimum needed to get the answer right and show all your logic).

PE 5: Do enough practice for each type of problem so that you are smooth.

Failure to meet these expectations will be reflected in lower test scores.

Late Policy

Assignments not submitted as directed by the due date will incur the following late penalty.

- No late homework/in-class assignments are accepted.
- Written assignments/projects/take-home tests are penalized at 10% per day for the first three days and a grade of 0% after that. Oral presentations are a 0 if not presented on the day assigned.

  Late paper submissions must include the date and time the paper is submitted and be in the credenza by 8am the next day. The next day penalty begins at 8am.
- In-class tests must be taken by the date given in class (or selected time in the case of an oral exam) unless there is incapacitating illness (see attendance policy below). Missing a test/taking the test late (including an oral exam) will result in a 10% penalty unless excused by the professor. Tests should be made up prior to the next class period unless other arrangements have been made with the professor.
- Work may always be completed early. Contact your professor if you wish to take a test early.

## Academic Integrity Policies

The university's Academic Integrity Policy is in effect (see `https://home.bju.edu/bju-policies/` for additional details).

### Definitions of Integrity Violations

Integrity is the reflection of the character and nature of God in our actions; therefore, students will be expected to work with integrity. In academia, violations of integrity generally fall into one or more of the following categories:

- Cheating: unauthorized use or attempted use of assistance, information, or aids in any academic assignment
- Falsification: submitting work done by others, changing work after submitting an assignment, reporting false information about the completion of an assignment
- Unacceptable collaboration: working with others when not permitted, using AI to generate ideas, thoughts, or content without the explicit permission of the professor
- Facilitation of Cheating: helping another student violate academic integrity, communicating quiz/test questions to other students
- Plagiarism: the intentional or unintentional use to any degree of the ideas or words of one's source material without proper acknowledgement

All work done for this class must represent your own effort, your own understanding, and your own communication of the material.

### Course Integrity Policies

If information is taken from other sources (which is at times appropriate), it always needs to be referenced and credit given where it is due. Use standard referencing techniques as taught in En 102. Solutions found on the internet are not to be copied.

- Homework: While you are encouraged to work together on the homework assignments, simply copying someone else's solution is neither useful nor acceptable. Your homework should represent your work and your understanding of the work.
- Tests (In-Class and Take-Home): No resources may be used while taking the test unless permitted by the professor. The presence of any unauthorized material on your desk, in your calculator, on your laptop, etc. while taking a test will be construed as cheating and will be dealt with as such.

  Internet/AI enabled devices or any communication devices (including but not limited to smart glasses, watches, earbuds, etc.) are not permitted to be used and should be stored out of sight during the testing period. Access these type of devices during the test will be construed as cheating and will be dealt with as such.

  Cheating on a test will likely result in a zero on the test and will be submitted to the Academic Integrity Committee.
- Projects: You are encouraged to discuss the general ideas needed to complete the project as discussed in this course with your classmates but are not permitted to "work together" on your project (outside of your own team and any faculty appointed advisors). Your projects must represent your own ideas, your own work, and your own communication of your work.

Assignment submissions will be evaluated for plagiarism and AI usage at the discretion of the professor. If you have a question about any source you are considering using, it is wise to gain your professor's approval before using it. You are always permitted to ask your professor for help. Any help they choose to provide is acceptable.

## AI Usage Policy

The goal of the assignments in this course is to learn to develop the skills covered, NOT to complete the tasks assigned. The use of AI to complete or jumpstart tasks defeats the goal of the assignments. Therefore, you may not use generative AI tools in this course for any assignment without the professor's express permission. AI tools include, but are not limited to, CoPilot, Apple Intelligence, Chat GPT, Bing Chat, Google Bard, Grok, Deepseek, Grammarly, and language translators.

Use of generative AI to develop code (such as Python or R) may be helpful during the project (each student has permission to use AI for only this purpose, other purposes require express permission). It would be wise to consult with your professor before incorporating it into your work. Reliance on AI to generate code has not yet resulted in an acceptable paper. If you do use it, you must document it as indicated above. You may NOT use AI to generate the text/discussion in your project.

## Documentation of Permitted AI Use

Should an AI tool be used with permission, its use must be documented (including the tool used, a summary of the prompts provided and the portions of the assignment that were based on AI generated work). See `https://style.mla.org/citing-generative-ai/` for details on citing the use of AI.