

# **Saint Mary's College**

## **Math 527 Applied Linear Algebra**

**Fall 2022 August 22 - December 16**

**Dr. Colleen Hoover**

**Email: [choover@saintmarys.edu](mailto:choover@saintmarys.edu)**

**Phone: 574-284-4774 (or 574-284-4575)**

### **Table of Contents:**

**Section 1: Course Information**

**Section 2: Instructor Information**

**Section 3: Course Description**

**Section 4: Course Goals and Outcomes**

**Section 5: Course Prerequisites**

**Section 6: Course Schedule, Assignments, Assessments**

**Section 7: Important Dates**

**Section 8: Time Zone: EST**

**Section 9: Course Textbook and Readings**

**Section 10: Course Grading Policy**

**Section 11: Class Cancellation**

**Section 12: Attendance and Participation Policy**

**Section 13: Online Code of Conduct**

**Section 14: Technical Support**

**Section 15: Technology Requirements**

**Section 16: Technology Skills**

**Section 17: Contingency Plan**

**Section 18: Academic Honesty**

**Section 19: Accessibility Support**

**Section 20: Academic Policies and Student Services**

## Section 1: Course Information

**Course Title:** Math 527 Applied Linear Algebra

**Semester & Year:** Fall 2022

**Number of Credit Hours:** 3

**Coarse Format:** Online, asynchronous

## Section 2: Instructor Information

**Instructor:** Dr. Colleen M. Hoover

**Office No:** 135 LeMans Hall

**Email:** choover@saintmarys.edu

**Office Phone:** 574-284-4774 (or 574-284-4575)

**Office Fax Number:** 574-284-4325

**Office Hours:** Please email me with questions or to set up an appointment to talk by phone, Blackboard Collaborate, or Zoom.

The best way to communicate with me is through email. During the week, I will make every effort to respond within 24 hours. If you write me over the weekend, I will respond by noon (EST) Monday.

**If Saint Mary's email system is down for any reason, you may contact me via text at (574)261-8743.** Please use this only if email is unavailable.

## Section 3: Course Description

Linear algebra is a powerful tool used in data science. In particular, some important statistical and data mining methods require techniques from this field. Though this course includes a review of many concepts covered in a basic linear algebra course, the pace will be quick and the emphasis will be on more advanced applications. Topics include Gaussian elimination, matrix arithmetic, determinants, vector spaces and subspaces, linear transformations, eigenvalues and eigenvectors, diagonalization, inner products, orthogonality, Gram-Schmidt process, least squares methods, matrix decomposition/factorization (LU or LDU, QR, spectral, singular value), special matrices (symmetric, positive definite, pseudo-inverses), principal component analysis, quadratic forms, Markov processes, and data/image processing.

## Section 4: Course Goals and Outcomes

### Learning Outcomes:

1. The student will acquire the ability to think clearly and critically about complex problems in linear algebra.

2. The student will demonstrate proficiency with the foundational concepts of linear algebra that underlie its application to data science.
3. The student will learn how to apply the dimension-reduction techniques of singular value decomposition and principal component analysis to problems in data science.
4. The student will develop facility with the computational tool *Octave*.
5. The student will communicate mathematical results in a precise and organized manner.

**Program Outcomes Addressed in this Course:**

- The graduate applies and fine-tunes computing resources for data analysis, including programming and industry-standard tool use.
- The graduate develops and implements data analysis strategies based on theoretical principles and detailed knowledge of the underlying data.
- The graduate rigorously applies mathematical principles to the analysis of data.

## Section 5: Course Prerequisites

A linear algebra class at the undergraduate level or some experience with the subject is preferred. A student who has no experience with linear algebra should work through all of the review materials in Week 1 and should make use of the optional resources discussed in Section 9.

## Section 6: Course Schedule, Assignments, Assessments

**Weekly Schedule:**

**Week 1**

Material: Review Module, Strang 1.1-1.3

Topics: Vectors, Lines, Planes Review; Overview of Course; Geometry of Linear Systems; An Example of Gaussian Elimination

Assessments: Quiz 1

**Week 2**

Material: Strang 1.4-1.7

Topics: Matrix Notation and Matrix Multiplication, Triangular Factors and Row Exchanges (LU and LDU Decomposition), Inverses and Transposes, Special Matrices and Applications

Assessments: Quiz 2

**Week 3**

Material: Strang 2.1, 2.2, 2.3

Topics: Vector Spaces and Subspaces, Solving  $Ax = 0$  and  $Ax = b$ , Linear Independence, Basis, and Dimension

Assessments: Quiz 3

**Week 4**

Material: Strang 2.4, 2.6

Topics: Four Fundamental Subspaces, Linear Transformations

Assessments: Quiz 4

**Week 5**

Material: No new material. Begin Chapter 3 to get ahead!

Assessments: Exam 1

**Week 6**

Material: Strang 3.1, 3.2

Topics: Orthogonal Vectors and Subspaces, Projections

Assessments: Quiz 5

**Week 7**

Material: Strang 3.3, 3.4

Topics: Least Squares (Weighted Least Squares), Orthogonal Bases and Gram-Schmidt

Assessments: Quiz 6

**Week 8**

Material: Strang 4.1, 4.2, 4.3

Topics: Determinants–Properties and Formulas

Assessments: Quiz 7

**Week 9**

Material: Strang 5.1, 5.2

Topics: Eigenvalues and Eigenvectors, Diagonalization

Assessments: Quiz 8

**Week 10**

Material: Strang 5.3, 5.5

Topics: Difference Equations, Markov Processes, Complex Matrices (Hermitian, Orthogonal Matrices)

Assessments: Quiz 9

**Week 11**

Material: Strang 5.6

Topics: Similarity Transformations, Spectral Theorem and Spectral Decomposition

Assessments: Exam 2

**Week 12**

Material: Strang 6.1, 6.2

Topics: Topics: Positive Definite Matrices–Max, Min, and Saddle Points, Tests for Positive Definiteness, Generalized Eigenvalue Problem

Assessments: Quiz 10

**Week 13**

Material: Strang 6.3

Topics: Singular Value Decomposition with Applications

Assessments: Quiz 11

## Week 14

Material: Strang 7.1-7.3

Topics: Matrix Norm, Condition Number, Computation of Eigenvalues

## Week 15

Material: Supplementary Materials

Topics: Principle Component Analysis

Assessments: Quiz 12

## Week 16

Course Review and Final Exam

### Information about Assessment Tools:

Students should expect to spend at least 9-12 hours per week on this course (including reading, studying, watching videos, and completing homework and quizzes). Your time invested in reading, watching videos, and doing homework will affect your performance on assignments, tests, and quizzes. You should remain current with the work. You are welcome and encouraged to discuss homework or raise questions about the material through the use of the discussion boards.

- **Quizzes:** There is a quiz almost every week in which there is no test. The two lowest quiz grades will be dropped. Students have one opportunity for each quiz. Students are expected to complete each quiz individually with no personal or virtual assistance. Students are allowed to use their notes, textbook, and computer to take quizzes. While use of notes and textbook is allowed, it is recommended that students attempt to take the quizzes without notes and textbook to better prepare themselves for the exams. Each quiz is due by 11:59 p.m. on the Sunday at the end of the week in which it is assigned.

### Submission of quizzes

You may choose one of two methods to submit quizzes that cannot be entirely completed in Blackboard. Quizzes that can be completed in Blackboard will be so indicated.

**Method 1:** Print the quiz, complete the work, and scan it to submit to me as a single PDF. I will grade it and scan the graded work to you.

**Method 2:** This method is for those with a tablet or iPad. Use a PDF reader that allows you to annotate using a stylus or iPencil. Some good options on an iPad are: Notability (~ \$9.99) or Good Notes (~ \$7.99). There are other PDF readers that allow you to annotate.

To employ this method, you would need to open the quiz PDF in your annotator program, annotate the quiz, and then email the quiz to me as a single PDF.

- **Octave Labs:** Students will complete lab assignments designed to establish proficiency in using the language and computing environment *Octave* (or its close relation, MATLAB) to perform linear algebra computation. (See Section 15 for more information on *Octave*) Students will submit a file containing their *Octave* results as per

instructions found on the Blackboard site under the folder called *Octave Resources*; scroll down to this link:

### How to Submit Octave Work

- **Exams** are individual assignments covering large parts of the course material. Each exam will have two parts, a proctored portion that will be completed entirely in Blackboard and a written portion. When taking the proctored portion of the exams, students may use a calculator but **NO OTHER RESOURCES**. For certain problems (as specified in the directions) of the non-proctored part of the test, students are allowed to use Octave, Matlab, or Python. For the written part of the exam that cannot be submitted via Blackboard, students may scan their written work and email to the instructor, fax their written work to the instructor, or annotate a PDF on a tablet or iPad and email the result.

For the proctored portion of exams, we will use the Respondus LockDown Browser and Monitor. (Using this service allows you to take the test at your convenience as opposed to being limited to the hours that a proctoring service is open.) This is a custom browser that locks down the test environment. You will not be able to print or access other applications or websites while in the browser. The webcam can be built into the student's computer or can be the type that plugs in with a USB cable. Note: You won't be able to access tests with a standard web browser. If this is tried, an error message will indicate that the test requires the use of LockDown Browser. Simply start LockDown Browser and navigate back to the exam to continue.

Students should watch the following short video to get a basic understanding of Lock-Down Browser and the webcam feature: <https://youtu.be/XuX8WoeAycs>.

A student Quick Start Guide (PDF) is also available on Blackboard in the folder entitled "LockDown Instructions."

- **Exam Proctors (optional):**  
**Any student who elects NOT to use the Respondus Lockdown Browser with Monitor service must use an official proctoring service that has been approved in advance by the instructor of this course.** Many community colleges and public libraries offer proctoring services for a small fee. For information on proctoring services, see, for example, [National College Testing Association](#). By the end of the **second** week of the semester, any student NOT choosing to use Respondus Lockdown Monitor must have made arrangements for a proctoring service and have provided the instructor with information about the service, including contact information for a representative at the service capable of making arrangements for exams.

**Graduate students who live near campus** may have the option of taking the exams in our testing center, depending on Covid protocols at that point in the semester. Contact the instructor if this is preferred.

- Any quiz or exam material emailed to the instructor should be sent **AS A SINGLE PDF**.
- All assignments will be graded for mathematical correctness in terms of content, completeness, notation, and mathematical language.

- **DUE DATES:** If a student fails to meet the due date for any test, quiz, or assignment, he/she earns a grade of 0 on that assignment unless prior arrangements have been made.

## Section 7: Important Dates

**First Day of Classes: August 22, 2022**

**Last Day of Classes: Thursday, December 8, 2022**

**Fall Break: October 17-23**

**Test Dates:**

Week 5—Exam 1 is due no later than 11:59 p.m. EST on Sunday, September 25, 2022.

Week 11—Exam 2 is due no later than 11:59 p.m. EST on Sunday, November 13, 2022.

**Final Exam Date:**

Week 16—The final exam is due no later than 11:59 p.m. EST on the Friday of final exam week, i.e., December 16, 2022.

**REMINDER:** A student who fails to meet the due date for any test, quiz, or assignment earns a grade of 0 on that assignment unless prior arrangements have been made.

## Section 8: Time Zone: EST

All due dates and times are given in EST. Make sure to adjust to your own time zone.

## Section 9: Course Textbook and Readings

**Required Text:** *Linear Algebra and Its Applications* (fourth edition) by Gilbert Strang.

**Optional Resources:**

- Graphing calculator. You may wish to have a calculator capable of doing matrix computations, such as a TI 83 or 84. You can do matrix computations with *Octave*.
- Student Solutions Manual (ISBN-10: 0495013250 — ISBN-13: 9780495013259)  
Includes detailed step-by-step solutions to selected odd-numbered problems.  
List Price = \$103.95  
- See more at: [Student Solutions Manual](#)
- For additional review of linear algebra concepts, see *Linear Algebra and Its Applications* by David C. Lay, et al.
- Video lectures on linear algebra by Gilbert Strang: Here is the url:  
<http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/>  
Click on this link: [Video lectures on linear algebra by Gilbert Strang](#)

- There are also resources identified on the Blackboard site for this course under the tab “Additional Resources.” Here you will find other videos and notes on linear algebra.

## Section 10: Course Grading Policy

### Course Evaluation:

10 highest quizzes, together worth	20%
<i>Octave</i> labs, together worth	10%
2 exams (each worth 20%)	40%
cumulative final exam worth	30%

### How Grades are Calculated:

The grade is based on percentages of your total points. The scale is

• 92-100%	A
• 88-91%	A-
• 84-87%	B+
• 80-83%	B
• 76-79%	B-
• 72-75%	C+
• 68-71%	C
• 64-67%	C-
• 50-63%	D
• 0-49%	F

**If a student receives a grade lower than a B- for this course, the course will not count toward the MS in Data Science Degree.**

## Section 11: Class Cancellation

Since there are no synchronous course activities planned, the class should not need to be cancelled. In the event of a serious emergency, students will be notified by email as soon as possible.

## Section 12: Attendance and Participation Policy

Students are encouraged and expected to participate in forum discussions. This is a good way to get insights from your classmates as well as test your own understanding of a topic. If you are dealing with a serious illness or a family emergency (Covid-19 or other) that is preventing you from completing course work at any point, please let the instructor know so that arrangements can be made to extend your time.

## Section 13: Online Code of Conduct

- Students are expected to treat other participants in the course with respect in all oral and written communication.
- Every person should feel comfortable asking any question about the course material or procedures. I simply ask that you treat each other with the same respect you would wish to receive.
- Though discussion of course material is encouraged, a student should not contact a fellow student about any matter unrelated to course material without that student's permission.

When participating in a discussion forum, keep the following rules in mind:

- Read before posting—make sure someone else didn't just ask the same question.
- Use informative titles.
- Proofread.
- Limit each thread to one topic.
- Keep the site friendly. If you notice a comment that is inappropriate, notify the instructor as soon as possible.

## Section 14: Technical Support

**For technical assistance, please contact ResNet, Saint Mary's College Information Technology Helpdesk.**

Email: [resnet@saintmarys.edu](mailto:resnet@saintmarys.edu)

Phone Number: 574-284-5319

Website: <http://www.saintmarys.edu/resnet>

### General Blackboard Help

Here is a linked page that our BB team created to provide you help with BB:

<https://www.saintmarys.edu/portal/itrc/blackboard-support>

### Blackboard Collaborate Technical Support

Blackboard Collaborate offers 24/7 support for both students and faculty.

Phone Number: 877-382-2293

Online knowledgebase: <https://help.blackboard.com/Collaborate/Ultra/Participant>

### Students Experiencing Technology Problems

- Students experiencing problems with their computers or internet access need to contact their instructor as soon as possible to explain the problem and how long it will take to resolve.

- Students should make an offline note of all contact information for the instructor (all email addresses, all telephone numbers, etc.) so they can successfully communicate with the instructor regardless of any technology failures.
- For problems with course software, contact the instructor. Alternately, one can obtain support for *Octave* at <http://www.gnu.org/software/octave/support.html>

## Section 15: Technology Requirements

### Technology Requirements

- A computer (hardware recommendations)

#### Minimum Systems Requirements

MAC	Windows
Mac OS X version 10.12 or later An Intel Core Duo/Core 2 Duo processor or an Intel Core i5/i7 processor At least 8 GB RAM At least 80 GB free space on hard drive	One of the following: Windows 10 or later, Windows 8, Windows 8 Pro, Windows 7 Ultimate Edition, Windows 7 Professional Edition, Windows Vista Ultimate Edition, Windows Vista Business Edition  One of the following: 1.5 GHz Pentium M processor or better, and Intel Core Duo/Core2 Duo processor, or an Intel Core i5/i7 processor  At least 8 GB RAM  At least 80 GB free space on hard drive

- Reliable high speed Internet connection
- *Octave* or MATLAB:

*Octave* is open source and freely available (and similar to MATLAB). We will use it for matrix calculations. Instructions for downloading *Octave* can be found on the Blackboard site for the course under the tab called *Octave Resources*: [Instructions for downloading Octave](#)

Note that a student can also learn about downloading a copy of *Octave* at the site:

<https://www.gnu.org/software/octave/#install/>

Click on this link: [Octave software](#)

For additional *Octave* packages, go to

<http://octave.sourceforge.net/packages.php>

Click on this link: [Octave packages](#).

The instructor will advise students if they need any of these additional packages.

MATLAB is the more user-friendly alternative to *Octave*, but it is not open source. Unless you have existing access, you will either need to purchase a one-year student license to MATLAB or access our laboratory computers remotely.

For information on how to access campus computer clusters from off campus, go to

<http://my.saintmarys.edu/web/information-technology>

and click on the “Remote Cluster Access” link. From off campus, **you will need to be connected to the VPN before accessing the computers remotely**. The student VPN instructions are also available at the information technology website.

- Software packages: Microsoft Office, free with Microsoft Campus Agreement
- Webcam
- Microphone
- Graphing calculator (This is optional. See Section 9.)
- A printer and scanner ( for submission of printed materials) or a tablet for annotation.

## Section 16: Technology Skills

A student is expected to be able to

- learn to use the language and computing environment *Octave* (or MATLAB),
- navigate the learning management system Blackboard,
- manage communication through a virtual meeting platform (Collaborate, Google Meet, or Zoom) and email.

## Section 17: Contingency Plan

Please **print and keep a copy** of this document in the event that Blackboard becomes unavailable.

### Instructor Emergency Contact

Name: Colleen M. Hoover

Phone Number: 574-284-4774

Emergency Alternative: Text or call 574-261-8743

### Blackboard: Expected Downtime

If Blackboard is undergoing scheduled maintenance, notification will be posted on the Blackboard log-on page: <http://bblearn.saintmarys.edu>

### **Unexpected Downtime**

In the unlikely event of campus-wide power failure or system crashes which render Blackboard and/or gmail unavailable, you may be notified by phone or by your alternative email address on file.

**Technology Downtime:** If/when the campus resources are not available, information about the outage will be posted at the following locations:

Blackboard Log-on page: <http://bblearn.saintmarys.edu>

ResNet website: <http://www.saintmarys.edu/resnet>

ResNet Facebook page: <https://www.facebook.com/ResNetSMC>

ResNet Twitter: @ResNetSMC

**File Backup:** Always keep a backup copy of course-related files on your computer, Google Drive, portable storage devices, etc.

**Instructors will ask for additional contact information for each student (alternate email addresses, telephone numbers, etc.) so if there are any technology issues, communication with each student can continue.**

## **Section 18: Academic Honesty**

We will follow the procedures and policies as stated in the College Bulletin. **Please read** those sections pertaining to the Academic Honesty Code. You may find the information at the Academic Affairs and First Year Studies website on Academic Policies (<http://www3.saintmarys.edu/first-year-policies> or click on [Academic Policies](#))

A student in this class who violates the Academic Honesty Policy will receive a failing grade on the relevant assignment, quiz, or test. A report of the incident will be sent to the Office of Academic Affairs.

## **Section 19: Accessibility Support**

For a **map of the campus**, see <https://www.saintmarys.edu/campus-map-accessibility>

**Accessibility Resource Office:** If you have had documented academic adjustments (accommodations) in the past, or think you may be eligible for them presently, you should contact the Accessibility Resource Office (ARO) at [aro@saintmarys.edu](mailto:aro@saintmarys.edu) to make an appointment to address this matter. The ARO is responsible for coordinating academic accommodations for students each semester and will issue a letter of documentation to your faculty for the current semester. Requests for such accommodations will not be honored without this letter from the ARO. Securing reasonable accommodations requires timely action on the part of the student. Please contact [aro@saintmarys.edu](mailto:aro@saintmarys.edu) for an appointment to discuss how we will implement your accommodations.

## Section 20: Academic Policies and Student Services

For general information on academic services and campus-wide policies, please read the Institutional Syllabus, available on Blackboard or on the Registrar's website at

<https://www.saintmarys.edu/academics/resources/registrar>.

For additional information on resources for graduate students, see

<https://grad.saintmarys.edu/student-resources>

For information on academic policies related to graduate students, please scroll down to the relevant topic in this section of the Graduate Bulletin: <https://catalog.saintmarys.edu/graduate/>