



## MATH-221 – Elementary Linear Algebra

University Arts and Science

**Effective Term & Year:** Fall 2026

**Course Outline Review Date:** 2031-03-01

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**Program Area:** Math and Sciences

### **Description:**

Linear algebra is the field of mathematics with the broadest set of applications in the modern world. It provides the language we use to describe complicated, interdependent systems in simple ways. Students study using vectors to describe surfaces or volumes embedded in higher dimensional spaces; they study how matrices are used to transform these vectors, surfaces, and volumes into other shapes; and they learn how complicated systems can be rewritten in terms of simple equations involving multiplying matrices and vectors. It is a field which is used extensively in computer science, applied mathematics, and physics as well as engineering.

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### **Program Information:**

This course is required for majors in Math, Physics, and Engineering. It is required for students pursuing the Engineering Certificate who want to transfer into Engineering at the University of British Columbia or the University of Victoria. This course can also be used as an elective in several University Studies Programs. Refer to the College Program Guide for additional information.

**Delivery Methods:** On-campus (Face-to-Face)

**Credit Type:** College of the Rockies Credits

**Credits:** 3

**Course type/s:** Sciences

### **Instructional Activity and Hours:**

Activity	Hours
Classroom, Directed Studies or Online Instruction	45
Seminar/Tutorials	
Laboratory/Studio	
Practicum/Field Experience	
Co-op/Work Experience	
Other	
Total	45

### Course Requisites:

- Complete all of the following
  - Completed the following:
    - [MATH103](#) – Differential Calculus (3)
    - [MATH104](#) – Integral Calculus (3)
  - Except students enrolled in Engineering. (MATH 104 may be taken concurrently).

### Prior Learning and Recognition: Yes

Students are able to request formal recognition of their prior learning or experience outside the classroom. Challenge examination, portfolio-assisted assessment, work-based assessment or a combination of assessments that is appropriate to identify, assess, and recognize prior skills, competencies, and knowledge to achieve course credit. Tuition fees apply, refer to [Policy 2.5.5 Prior Learning Assessment and Recognition \(PLAR\)](#) or contact an education advisor for more information.

### Course Transfer Credit:

For information about receiving transfer credit for courses taken at either British Columbia or Alberta institutions, please see <https://www.bctransferguide.ca/> or <https://transferalberta.alberta.ca> . For more transfer credit information, please visit <https://www.cotr.bc.ca/Transfer>

All requests for course transfer credit from institutions in British Columbia or elsewhere should go to the College of the Rockies Enrolment Services office.

### Textbook Resources:

Textbook selection varies by instructor and may change from year to year. At the course outline effective date the following textbooks were in use:

Possible texts used by this course include (but are not limited to):

Larson, R. (2017) *Elementary Linear Algebra* (8th ed). Cengage

Kuttler, K. (2017) *A First Course in Linear Algebra* (Open Text). Creative Commons License (CC BY)

*Please see the instructor's syllabus or check COTR's online text calculator <https://textbook.cotr.bc.ca/> for a complete list of the currently required textbooks.*

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### **Learning Outcomes:**

By the end of this course, successful students will be able to:

- solve systems of linear equations using Gauss-Jordan elimination;
  - perform matrix arithmetic including inverting matrices;
  - calculate determinants using cofactor expansion;
  - determine whether a matrix is invertible, and list its subsequent properties according to the Invertible Matrix Theorem;
  - use vectors to describe lines, planes or volumes in 2-, 3-, or n-space;
  - perform vector arithmetic including dot and cross products;
  - characterize a vector space or subspace in terms of its dimension, rank and nullity;
  - span a vector space in terms of a basis of vectors and use the Gram-Schmidt process to build an orthonormal basis;
  - use inner product calculations to define orthogonal projections and build orthonormal bases;
  - determine the characteristic polynomial of a matrix, and use its roots to determine the eigenvalues and eigenvectors of a matrix;
  - use the eigenvectors of a matrix to perform orthogonal diagonalization; and
  - analyze a linear transformation in terms of its kernel, range, and similarity.
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### **Course Topics:**

1. **Systems of linear equations**
  - a. Gaussian elimination
  - b. Matrices
  - c. Matrix arithmetic; inverses
2. **Determinants**
  - a. Properties of the determinant function
  - b. Cofactor expansion
  - c. The Invertible Matrix theorem
3. **Vectors on 2- and 3-space**

- a. Vector arithmetic
- b. Dot product
  - i. norm of a vector
  - ii. projections
- c. Cross products
- d. Lines and planes in 3-space
- 4. Euclidean vector spaces**
  - a. Euclidean n-space
  - b. Linear transformations  $R^n \rightarrow R^n$
- 5. Real vector spaces**
  - a. Axioms
  - b. Subspaces
  - c. Linear dependence
  - d. Basis and dimension
  - e. Row space, column space, null space
  - f. Rank and nullity
- 6. Inner product spaces**
  - a. Axioms
  - b. Angles and orthogonality
  - c. Orthonormal bases
  - d. Gram—Schmidt process
  - e. Best approximations
  - f. Orthogonal matrices; change of basis
- 7. Eigenvalues and eigenvectors**
  - a. Diagonalization
  - b. Orthogonal diagonalization
- 8. Linear transformations**
  - a. Kernel and Range
  - b. Inverse linear transformations
  - c. Similarity

*See instructor's syllabus for the detailed outline of weekly readings, activities and assignments.*

## Evaluation and Assessments

### Assessment Type: On-Campus (face-to-face)

Assessment Type	% of Total Grade
Assignments/Quizzes	20%
Midterm Tests	30%
Final Exam	50%
Total	100%

## Grade Scheme

A+	A	A-	B+	B	B-	C+	C	C-	D	F
>=90	89-85	84-80	79-76	75-72	71-68	67-64	63-60	59-55	54-50	<50

**No pass requirements available.**

**Evaluation Notes:** A grade of “D” grants credit, but may not be sufficient as a prerequisite for sequential courses.

**Exam Attendance:**

Students must attend all scheduled exams at the appointed time and place. Instructors may approve an alternate exam to accommodate an illness or personal crisis. Department heads will consider other written requests. Any student who misses a scheduled exam without prior approval will receive a “0” on the exam.

**Academic Policies:**

College of the Rockies policies related to courses can be found at <https://cotr.bc.ca/about-us/college-policies/> and include the following:

- Policy 2.1.4 Course Audit
- Policy 2.4.1 Credential Framework
- Policy 2.4.3 Students with Documented Disabilities
- Policy 2.4.4 Student Rights, Responsibilities and Conduct
- Policy 2.4.8 Academic Performance
- Policy 2.4.9 Student Feedback and Concerns
- Policy 2.4.11 Storage of Academic Works
- Policy 2.5.3 Student Appeal
- Policy 2.5.5 Prior Learning Assessment and Recognition (PLAR)

**Course Changes:**

The College of the Rockies updates course outlines regularly to meet changing educational, employment and marketing needs. The instructor will notify students in writing of any updates to this outline during the semester. The instructor reserves the right to revise, add or delete material while meeting the learning outcomes of this course outline.