COLLEGE OF THE ROCKIES

Elementary Linear Algebra – MATH 221

University Studies Program

Course Outline

COURSE IMPLEMENTATION DATE:	**Pre 1998**
OUTLINE EFFECTIVE DATE:	**September 2021**
COURSE OUTLINE REVIEW DATE:	**March 2026**

GENERAL COURSE DESCRIPTION:

This course is intended for students who are pursuing a Bachelor of Science (with a major in Computing, Mathematics, or Physics) or Applied Science (Engineering) degree. Topics include: systems of linear equations and matrices, matrix arithmetic, determinants, vectors, products of vectors, lines and planes in 2- and 3-space, Euclidean vector spaces, real vector spaces, inner product spaces, eigenvalues and eigenvectors, diagonalization, linear transformations, kernel, range, similarity, approximation and quadratic forms.

Linear algebra is used extensively in Computer Science, Engineering, Mathematics, Applied Mathematics, and Physics.

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: This course is delivered face to face.

COTR Credits: 3

Hours for this course: 45 hours

Typical Structure of Instructional Hours:

Instructional Activity	Duration
Lecture Hours	45
Seminars / Tutorials	
Laboratory / Studio Hours	
Practicum / Field Experience Hours	
Other Contact Hours	
Total	45

Practicum Hours (if applicable):

Type of Practicum	Duration
On-the-job Experience	N/A
Formal Work Experience	N/A
Other	N/A
Total	

Course Outline Author or Contact:
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Signature

APPROVAL SIGNATURES:

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Dean Signature

EDCO

Valid from: September 2021- March 2026

Education Council Approval Date

COURSE PREREQUISITES AND TRANSFER CREDIT:

Prerequisites: MATH 104 except students enrolled in first year Engineering. (MATH 103 for first year Engineering students (may be taken concurrently).

Corequisites: None

Flexible Assessment (FA):

Credit can be awarded for this course through FA ☑ Yes ☐ No

Learners may request formal recognition for flexible assessment at the College of the Rockies through one or more of the following processes: External Evaluation, Worksite Assessment, Demonstration, Standardized Test, Self-assessment, Interview, Products/Portfolio, Challenge Exam. Contact an Education Advisor for more information.

Transfer Credit: For transfer information within British Columbia, Alberta and other institutions, please visit http://www.cotr.bc.ca/Transfer.

Students should also contact an academic advisor at the institution where they want transfer credit.

Textbooks and Required 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):

- Linear Algebra with Applications (2019), Open Edition, Keith Nicholson, Creative Commons License (CC BY-NC-SA)
- A First Course in Linear Algebra (2017), Open text, Ken Kuttler, Creative Commons License (CC BY)

Please see the instructor's syllabus or check COTR's online text calculator http://go.cotr.bc.ca/tuition/tCalc.asp for a complete list of the currently required textbooks.

LEARNING OUTCOMES:

Linear algebra is required for students wishing to go on in Computer Science, Economics, Engineering, Mathematics, Applied Mathematics, and Physics.

At the completion of Math 221, a successful student will be able to

- Solve systems of linear equations using Gaussian and Gauss-Jordan elimination;
- Perform matrix arithmetic including inverting matrices;
- Calculate determinants using row reduction or cofactor expansion;
- Use Cramer's rule and understand its role in theoretical proofs;
- Understand vectors in 2- and 3-space, dot and cross products, lines and planes;
- Generalize the above to more than three dimensions;
- Understand the axiomatic approach to vector spaces including subspaces, linear independence, bases and dimension, rank and nullity;
- Understand the axiomatic approach to inner product spaces including orthonormal bases, orthogonal projections (including least squares and Fourier series) and orthogonal matrices;
- Use eigenvalues and eigenvectors to perform orthogonal diagonalization. Work with quadratic forms; and
- Understand the concept of linear transformation, kernel and range, and similarity.

This course should help students:

- Use written and oral communication skills effectively, employing methods appropriate to message and context;
- Think clearly and critically, fusing experience, knowledge and reasoning into considered judgment; and
- Identify, interpret, and solve problems, effectively implementing and evaluating proposed strategies.

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) Evaluating determinants by row reduction
   - c) Cofactor expansion
   - d) Cramer's rule

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, $R^n \rightarrow R^m$

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
     - i) Gram—Schmidt process
   - d) Best approximations
     - i) Least squares
     - ii) Fourier series
   - e) Orthogonal matrices; change of basis

7. Eigenvalues and eigenvectors
   - a) Diagonalization
     - i) Quadratic forms
       - a) Conic sections
       - b) Quadric surfaces
   - b) Orthogonal diagonalization

8. Linear transformations
    c) Kernel and Range
    d) Inverse linear transformations
    e) Similarity

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

EVALUATION AND ASSESSMENT (Face to Face Delivery):

Assignments	% Of Total Grade
Assignments/Quizzes	20%
Midterm Tests	30%
Final Exam	50%
Total	100%

Please see the instructor's syllabus for specific classroom policies related to this course, such as details of evaluation, penalties for late assignments, and use of electronic aids.

EXAM POLICY:

Students must attend all required scheduled exams that make up a final grade at the appointed time and place.

Individual instructors may accommodate for illness or personal crisis. Additional accommodation will not be made unless a written request is sent to and approved by the appropriate Department Head prior to the scheduled exam.

Any student who misses a scheduled exam without approval will be given a grade of "0" for the exam.

COURSE GRADE:

Course grades are assigned as follows:

Grade	A+	A	A-	B+	B	B-	C+	C	C-	D	F
Mark (Percent)	≥ 90	89-85	84-80	79-76	75-72	71-68	67-64	63-60	59-55	54-50	< 50

A grade of "D" grants credit, but may not be sufficient as a prerequisite for sequential courses.

ACADEMIC POLICIES:

See www.cotr.bc.ca/policies for general college policies related to course activities, including grade appeals, cheating and plagiarism.

COURSE CHANGES:

Information contained in course outlines is correct at the time of publication. Content of the courses is revised on an ongoing basis to ensure relevance to changing educational, employment and marketing needs. The instructor will endeavour to provide notice of changes to students as soon as possible. The instructor reserves the right to add or delete material from courses.