UNIVERSITY OF THE FRASER VALLEY

ORIGINAL COURSE IMPLEMENTATION DATE: May 1977
REVISED COURSE IMPLEMENTATION DATE: September 2019
COURSE TO BE REVIEWED (six years after UEC approval)**:** February 2025
Course outline form version: 05/18/2018

OFFICIAL UNDERGRADUATE COURSE OUTLINE FORM

Note: The University reserves the right to amend course outlines as needed without notice.

Course Code and Number: MATH 221	**Number of Credits:** 3 Course credit policy (105)

Course Full Title: Linear Algebra
Course Short Title:
(Transcripts only display 30 characters. Departments may recommend a short title if one is needed. If left blank, one will be assigned.)

Faculty: Choose an item.	**Department (or program if no department):** Mathematics & Statistics

Calendar Description:

Ideas and techniques from linear algebra lie at the core of much of mathematics and its applications in other sciences and technology. Topics include systems of linear equations, matrix algebra and determinants, vector spaces, linear transformations, diagonalization, and inner product spaces.

Prerequisites (or NONE):	C or better in one of MATH 112 or MATH 118.
Corequisites (if applicable, or NONE):	
Pre/corequisites (if applicable, or NONE):	

Antirequisite Courses *(Cannot be taken for additional credit.)*
Former course code/number:
Cross-listed with:
Dual-listed with:
Equivalent course(s):
(If offered in the previous five years, antirequisite course(s) will be included in the calendar description as a note that students with credit for the antirequisite course(s) cannot take this course for further credit.)

Typical Structure of Instructional Hours

Lecture/seminar hours	50
Tutorials/workshops	
Supervised laboratory hours	
Experiential (field experience, practicum, internship, etc.)	
Supervised online activities	
Other contact hours:	
Total hours	**50**

Labs to be scheduled independent of lecture hours: ☐ No ☐ Yes

Special Topics *(Double-click on boxes to select.)*
This course is offered with different topics:
☐ No ☐ Yes *(If yes, topic will be recorded when offered.)*

Independent Study
If offered as an Independent Study course, this course may be repeated for further credit: *(If yes, topic will be recorded.)*
☐ No ☐ Yes, repeat(s) ☐ Yes, no limit

Transfer Credit
Transfer credit already exists: *(See **bctransferguide.ca**.)*
☐ No ☒ Yes
Submit outline for (re)articulation:
☐ No ☐ Yes *(If yes, fill in transfer credit form.)*

Grading System
☒ Letter Grades ☐ Credit/No Credit

Maximum enrolment (for information only): 36

Expected Frequency of Course Offerings:
Annually *(Every semester, Fall only, annually, etc.)*

Department / Program Head or Director: Ian Affleck	**Date approved:**	October 22, 2018
Faculty Council approval	**Date approved:**	November 30, 2018
Dean/Associate VP: Lucy Lee	**Date approved:**	November 30, 2018
Campus-Wide Consultation (CWC)	**Date of posting:**	January 18, 2019
Undergraduate Education Committee (UEC) approval	**Date of meeting:**	February 1, 2019

Learning Outcomes:

Upon successful completion of this course, students will be able to:

Calculation:

- Use matrix techniques to solve linear systems.
- Perform the various calculations of matrix algebra.
- Check properties (or lack thereof) of vector spaces and their subsets: for example span, independence, dimension. The underlying vector spaces will not be limited to Euclidean n-space.
- Construct bases for given spaces and subspaces, including subspaces associated with a matrix (row space, column space, null space), but also including examples not in n-space.
- Calculate coordinates relative to given bases and change coordinates.
- Check whether a given function is a linear transformation.
- Represent a given linear transformation relative to a given basis; change bases.
- Calculate bases for range, kernel.
- Find eigenvalues, eigenvectors of a given matrix.
- Determine if a given matrix is diagonalizable, find a diagonal form if so.
- Verify if a given form is an inner product.
- Calculate projections on vectors, and on subspaces with an orthonormal basis.
- Perform Gram-Schmidt orthogonalization of a given set of vectors in an inner product space.

The successful student will be able to perform all of the calculations above by hand, and also by using appropriate software, such as Maple.

Concept:

- Accurately define the basic constructs and concepts of linear algebra including vector spaces, subspace, span, linear independence, basis, dimension, coordinates, linear transformation, eigenvalues/vectors, inner product (spaces), orthonormality, projection. The underlying vector spaces will include examples beyond Euclidean n-space, and the constructs may take place in an abstract space;
- More significantly, exhibit understanding of the concepts and constructs above by:
  (a) demonstrating a knowledge (through example and simple argument) of the connections between them;
  (b) verifying elementary true statements, and by supplying examples and counterexamples. These verifications may take the form of elementary arguments and proofs.

Application

- Use their knowledge of theory and techniques to model and solve simple problems from various disciplines and real-world situations;
- Effectively communicate their approach and solutions of such problems to others.

Prior Learning Assessment and Recognition (PLAR)

☒ Yes ☐ No, PLAR cannot be awarded for this course because

Typical Instructional Methods *(Guest lecturers, presentations, online instruction, field trips, etc.; may vary at department's discretion.)*

Lectures are interspersed with in-class problem sessions; evaluation includes assignments, term tests and a three-hour comprehensive final exam. A computer algebra system (e.g. Maple) will be used.

NOTE: The following sections may vary by instructor. Please see course syllabus available from the instructor.

Typical Text(s) and Resource Materials *(If more space is required, download Supplemental Texts and Resource Materials form.)*

The textbook is chosen by department curriculum committee. Examples might be:

	Author (surname, initials)	Title (article, book, journal, etc.)	Current ed.	Publisher	Year
1.	Leon	Linear Algebra with Applications	9th	Pearson	2014
2.			☐		
3.			☐		
4.			☐		
5.			☐		

Required Additional Supplies and Materials *(Software, hardware, tools, specialized clothing, etc.)*

Access to Maple software (available in UFV labs)

Typical Evaluation Methods and Weighting

Final exam:	35%	Assignments:	25%	Field experience:	%	Portfolio:	%
Midterm exam:	%	Project:	%	Practicum:	%	Other:	%
Quizzes/tests:	40%	Lab work:	%	Shop work:	%	Total:	100%

Details (if necessary): The weighting of the various components may vary from instructor to instructor and from year to year, although there must be at least two term tests, and the comprehensive final exam must be worth from 30% to 50% of the final grade. A student must obtain at least 40% on the final exam to pass the course.

An example:

Quizzes	10%
Assignments	25%
Term tests	30%
Final exam	35%

Typical Course Content and Topics

Note: Algebraic proofs of theorems will be included where appropriate, as will applications. The order of topics may vary. Applications will be included throughout.

1) Linear systems, matrix representation, row reduction, homogeneous systems

2) Matrix algebra, inverses, elementary matrices. The invertible matrix theorem

3) Determinants (definition via expansion by cofactors, elementary properties)

4) Vector spaces
   - Axiomatic definition, examples including but not limited to n-space
   - Subspace
   - Span, linear independence, basis, dimension
   - Subspaces associated with a matrix, rank
   - Coordinates relative to a basis, change of basis

5) Linear Transformations
   - Definitions and examples including but not limited to n-space
   - Properties, associated subspaces (kernel, range, rank)
   - Matrix representation, change of basis

6) Diagonalization
   - Eigenvalues/vectors
   - Diagonal forms, conditions for diagonalizability, diagonalization technique

7) Inner Product Spaces
   - Definitions and examples (including but not limited to dot product)
   - Projection on a vector
   - Orthogonal/normal sets, projection on a subspace
   - Gram-Schmidt process