UNIVERSITY OF THE FRASER VALLEY

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| COURSE IMPLEMENTATION DATE: | May 1977 |
| COURSE REVISED IMPLEMENTATION DATE: | September 2012 |
| COURSE TO BE REVIEWED: | October 2015 |
| *(six years after UEC approval)* | *(month, year)* |

## OFFICIAL UNDERGRADUATE COURSE OUTLINE INFORMATION

Students are advised to keep course outlines in personal files for future use.
Shaded headings are subject to change at the discretion of the department – see course syllabus available from instructor

| MATH 221 | SCIENCE/MATH & STATS | 3 |
|---|---|---|
| COURSE NAME/NUMBER | FACULTY/DEPARTMENT | UFV CREDITS |

Linear Algebra
COURSE DESCRIPTIVE TITLE

**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: MATH 112 with C or better, or MATH 118 with a C or better
COREQUISITES:
PRE or COREQUISITES:

**SYNONYMOUS COURSE(S):**
(a) Replaces:
(b) Cross-listed with:
(c) Cannot take: MATH 152 for further credit.

**SERVICE COURSE TO:** *(department/program)*

**TOTAL HOURS PER TERM:** **45**

STRUCTURE OF HOURS:

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| Lectures: | **45** | Hrs |
| Seminar: | | Hrs |
| Laboratory: | | Hrs |
| Field experience: | | Hrs |
| Student directed learning: | | Hrs |
| Other (specify): | | Hrs |

TRAINING DAY-BASED INSTRUCTION:
Length of course:
Hours per day:

**OTHER:**
Maximum enrolment: 36
Expected frequency of course offerings: annually
*(every semester, annually, every other year, etc.)*

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| WILL TRANSFER CREDIT BE REQUESTED? (lower-level courses only) | ☒ Yes | ☐ No |
| WILL TRANSFER CREDIT BE REQUESTED? (upper-level requested by department) | ☐ Yes | ☐ No |
| TRANSFER CREDIT EXISTS IN BCCAT TRANSFER GUIDE: | ☒ Yes | ☐ No |

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| Course designer(s): | **Greg Schlitt** | | |
| Department Head: | **Greg Schlitt** | Date approved: | **December 15, 2011** |
| Supporting area consultation **(Pre-UEC)** | | Date of meeting: | **February 3, 2012** |
| Curriculum Committee chair: | **Norm Taylor** | Date approved: | **January 27, 2012** |
| Dean/Associate VP: | **Ora Steyn** | Date approved: | **February 10, 2012** |
| Undergraduate Education Committee (UEC) approval | | Date of meeting: | **March 2, 2012** |

**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.

**METHODS:** *(Guest lecturers, presentations, online instruction, field trips, etc.)*

Lectures are interspersed with in-class problem sessions; evaluation includes assignments, term tests and a three-hour comprehensive final exam. Graphing calculators will be used. In addition, mathematical software will be used.

**METHODS OF OBTAINING PRIOR LEARNING ASSESSMENT RECOGNITION (PLAR):**

☒ Examination(s) ☒ Portfolio assessment ☐ Interview(s)

☒ Other (specify):Course Challenge

☐ PLAR cannot be awarded for this course for the following reason(s):

**TEXTBOOKS, REFERENCES, MATERIALS:**

*[Textbook selection varies by instructor. An example of texts for this course might be:]*

The textbook is chosen by department curriculum committee. Examples might be:
Contemporary Linear Algebra by Anton, Busby. Wiley, 2003

**SUPPLIES / MATERIALS:**

Access to Maple software

**STUDENT EVALUATION:**

*[An example of student evaluation for this course might be:]*

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:

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| Quizzes | 10% |
| Assignments | 20% |
| Term tests | 30% |
| Final exam | 40% |

**COURSE CONTENT:**

*[Course content varies by instructor. An example of course content might be:]*

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
   a) axiomatic definition, examples including but not limited to n-space
   b) subspace
   c) span, linear independence, basis, dimension
   d) subspaces associated with a matrix, rank
   e) coordinates relative to a basis, change of basis

5) Linear Transformations
   a) definitions and examples including but not limited to n-space
   b) properties, associated subspaces (kernel, range, rank)
   c) matrix representation, change of basis

6) Diagonalization
   a) eigenvalues/vectors
   b) diagonal forms, conditions for diagonalizability, diagonalization technique

7) Inner Product Spaces
   a) definitions and examples (including but not limited to dot product)
   b) projection on a vector
   c) orthogonal/normal sets, projection on a subspace
   d) Gram-Schmidt process