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| CAMOSUN COLLEGE | **School of Arts & Science**<br>**MATHEMATICS DEPARTMENT**<br>**MATH 251**<br>**Matrix Algebra for Engineers**<br>**Quarter or Semester/Year** |

# COURSE OUTLINE

**The course description is online @ http://camosun.ca/learn/calendar/current/web/math.html**

Ω *Please note: the College electronically stores this outline for five (5) years only.*
*It is **strongly recommended** you keep a copy of this outline with your academic records.*
*You will need this outline for any future application/s for transfer credit/s to other colleges/universities.*

## 1. Instructor Information

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| (a) | Instructor: | Gilles Cazelais | | |
| (b) | Office Hours: | http://pages.pacificcoast.net/~cazelais/schedule.html | | |
| (c) | Location: | CBA 158 | | |
| (d) | Phone: | 370-4495 | Alternative Phone: | |
| (e) | Email: | cazelais@camosun.bc.ca | | |
| (f) | Website: | http://pages.pacificcoast.net/~cazelais/ | | |

## 2. Intended Learning Outcomes

*(No changes are to be made to these Intended Learning Outcomes as approved by the Education Council of Camosun College.)*

Upon completion of this course the student will be able to:

1. Determine the dimension of a matrix. State and use the properties of matrices, matrix inverses, and matrix transposes. Add subtract, and multiply two matrices. Find the transpose, scalar multiple, and inverse of a matrix. Express a matrix product as a linear combination.
2. Determine the inverse of a matrix by the Gauss-Jordan Method and by the Adjoint Matrix method. Solve linear systems using the augmented matrix method, Cramer's Rule and by using inverse matrices. Recognize and make use of the properties of diagonal, triangular, and symmetric matrices.
3. Evaluate determinants by reducing the associated matrix to row-echelon form, by the method of co-factors, and by using the properties of determinants.
4. Graph points and vectors in three-dimensions. Apply vector operations to two-dimensional, and three-dimensional vectors. State and use the properties of inner products to determine the angle between vectors, and the projection of vector **u** upon vector **v**. Calculate the norm, the dot product, cross product, and triple scalar product of two three-dimensional vectors.
5. Express the equation of a line in space in parametric, vector, and standard form. Express the equation of a plane in space in point-normal, vector and standard forms. Find the distance between points, planes, and lines in space. Use the cross product to find the areas of triangles, parallelograms, and the volume of a pyramid.
6. Extend the properties of vectors in two-dimensional and three-dimensional space to Euclidean n-space.
7. Identify and employ the matrices for reflection, projection, counter clockwise rotation, and dilation and contraction operators in $R^2$ and $R^3$.
8. State the properties of a real vector space, and use them to establish whether a given subset of $R^n$ with given operations of addition and scalar multiplication form a vector space. Determine whether a subset of a vector space forms a subspace.
9. Define linear independence and dependence and determine whether two vectors determine a linearly independent set. Use the Wronskian to determine whether functions are linearly independent or dependent.
10. Determine the dimension of a vector space. Determine whether a given set of vectors form a basis for a vector space. Find the coordinates of a vector with respect to a given basis. Find the span of a given set of vectors.
11. Find bases for the row space, column space, and nullspace of a given matrix. Find a subset of a given set of vectors that forms a basis for the space spanned by these vectors. Determine the rank and nullity of a matrix.

12. Determine if a given function is an inner product for a given vector space. Use a weighted Euclidean inner product, an inner product generated by a matrix, an integral inner product, or any given inner product to find the norm of a vector in the associated vector space.
13. State the Cauchy-Schwarz Inequality and the properties of length and distance. For any two vectors in an inner product space determine the angle between them, and find the distance between them. Use the fact that the nullspace and the row space of A are orthogonal complements in $R^n$ to determine a basis for the orthogonal complement for a given set of vectors.
14. Use the Gram-Schmidt process to transform a given basis of vectors in any non-zero finite-dimensional inner product space into an orthonormal basis for that space.
15. Determine the least squares solution of a given linear system $A\mathbf{x} = \mathbf{b}$.
16. Given that $B_1$ and $B_2$ are any two bases of a vectors space, find the transition matrix for a change of basis from $B_1$ to $B_2$ and use the result to determine the coordinates of a given vector relative to the new basis.
17. Determine the eigenvalues and eigenvectors of a given square matrix. Determine the bases for the eigenspaces of a given square matrix. Determine a basis for $R^n$ consisting of eigenvectors of a given square matrix. Determine if a given square matrix A is diagonalizable and if it is, find a matrix that diagonalizes A.
18. Determine if a function from one vector space to another is linear. Given the images of standard basis vectors under a linear transformation, determine a formula for the linear transformation. Determine bases for the kernel and the range of a given linear transformation. Determine rank and nullity of a given matrix. Determine the matrix for a linear transformation between finite-dimensional vector spaces.
19. Use linear algebra to construct equations of: lines through 2 points, circles through 3 points, and a general conic through 5 points.
20. Express complex numbers as vectors or points in the complex plane and geometrically determine sums, differences, and scalar multiples of complex numbers. Represent complex numbers in rectangular, polar form, and exponential form. Determine the sum, difference, product, and quotient of two complex numbers. Determine the modulus and conjugate of a complex number. Use the properties of the conjugate to simply complex expressions. Use Demoivre's Formula to determine the nth roots of a complex number.

## 3. Required Materials

David Poole, *Linear Algebra A Modern Introduction*, 3rd edition.

## 4. Course Content and Schedule

1. Vectors
_ The Geometry and Algebra of Vectors (1.1)
_ Length and Angle: The Dot Product (1.2)
_ Lines and Planes (1.3)
_ Exploration: The Cross Product

2. Systems of Linear Equations
_ Introduction to Systems of Linear Equations (2.1)
_ Direct Methods for Solving Linear Systems (2.2)
_ Spanning Sets and Linear Independence (2.3)
_ Applications (2.4)

3. Matrices
_ Matrix Operations (3.1)
_ Matrix Algebra (3.2)
_ The Inverse of a Matrix (3.3)
_ The LU Factorization (3.4)
_ Subspaces, Basis, Dimensions, and Rank (3.5)
_ Introductions to Linear Transformations (3.6)

4. Complex Numbers (Appendix C)

5. Eigenvalues and Eigenvectors
_ Introduction to Eigenvalues and Eigenvectors (4.1)
_ Determinants (4.2)
_ Exploration: Geometric Applications of Determinants

_ Eigenvalues and Eigenvectors of n _ n matrices (4.3)
_ Similarity and Diagonalization (4.4)
_ Applications (4.6)

6. Orthogonality
_ Orthogonality in $R^n$ (5.1)
_ Orthogonal Complements and Orthogonal Projections (5.2)
_ The Gram-Schmidt Process and the QR Factorization (5.3)
_ Orthogonal Diagonalization of Symmetric Matrices (5.4)
7. Distance and Approximation
_ Least Squares Approximation (7.3)

## 5. Basis of Student Assessment (Weighting)

- Two tests: 40%
- Assignments: 10%
- Final Exam: 50%

## 6. Grading System

*(No changes are to be made to this section unless the Approved Course Description has been forwarded through the Education Council of Camosun College for approval.)*

**Standard Grading System (GPA)**

| Percentage | Grade | Description | Grade Point Equivalency |
|---|---|---|---|
| 90-100 | A+ | | 9 |
| 85-89 | A | | 8 |
| 80-84 | A- | | 7 |
| 77-79 | B+ | | 6 |
| 73-76 | B | | 5 |
| 70-72 | B- | | 4 |
| 65-69 | C+ | | 3 |
| 60-64 | C | | 2 |
| 50-59 | D | Minimum level of achievement for which credit is granted; a course with a "D" grade cannot be used as a prerequisite. | 1 |
| 0-49 | F | Minimum level has not been achieved. | 0 |

**Temporary Grades**

Temporary grades are assigned for specific circumstances and will convert to a final grade according to the grading scheme being used in the course. See Grading Policy E-1.5 at **camosun.ca** for information on conversion to final grades, and for additional information on student record and transcript notations.

| Temporary Grade | Description |
|---|---|
| **I** | *Incomplete*: A temporary grade assigned when the requirements of a course have not yet been completed due to hardship or extenuating circumstances, such as illness or death in the family. |
| **IP** | *In progress*: A temporary grade assigned for courses that, due to design may require a further enrollment in the same course. No more than two IP grades will be assigned for the same course. *(For these courses a final grade will be assigned to either the 3rd course attempt or at the point of course completion.)* |
| **CW** | *Compulsory Withdrawal:* A temporary grade assigned by a Dean when an instructor, after documenting the prescriptive strategies applied and consulting with peers, deems that a student is unsafe to self or others and must be removed from the lab, practicum, worksite, or field placement. |

## 7. Recommended Materials or Services to Assist Students to Succeed Throughout the Course

**LEARNING SUPPORT AND SERVICES FOR STUDENTS**

There are a variety of services available for students to assist them throughout their learning.
This information is available in the College calendar, at Student Services, or the College web site at camosun.ca.

**STUDENT CONDUCT POLICY**

There is a Student Conduct Policy **which includes plagiarism**.
It is the student's responsibility to become familiar with the content of this policy.
The policy is available in each School Administration Office, at Student Services,
and the College web site in the Policy Section.

ADDITIONAL COMMENTS AS APPROPRIATE OR AS REQUIRED