WINONA STATE UNIVERSITY

COLLEGE OF SCIENCE AND ENGINEERING

DEPARTMENT OF MATHEMATICS AND STATISTICS

**Course Outline-MATH 142**

**Title:** Matrix Algebra

**Number of Credits:** 3

**Catalog Description:**  Anintroduction to matrix algebra, including row-reduction, matrix arithmetic, linear transformations, linear independence, and span. Emphasis is on conceptual understanding, computation, and applications. Prerequisite: MATH 112 or MATH 115. Meets GOAL 4.

**Possible Textbooks:**

* Elementary Linear Algebra with Applications by Howard Anton
* Elementary Linear Algebra with Applications by Richard Hill
* Introduction to Linear Algebra by L. Johnson, R. D. Riess and J. Arnold
* Linear Algebra and its Applications by David C. Lay

**Topics covered:**

1. Systems of Linear Equations
   1. Gaussian Elimination
   2. Existence and Uniqueness
   3. Vector and Matrix Equations
2. Linear Transformations
   1. Matrix form of Isometries
   2. Eigen-analysis of transformations
   3. Creating linear transformations
   4. Iterated Function Systems
3. Matrices
   1. Operations
   2. Diagonal, Upper and Lower Triangular Matrices
   3. Inverses
   4. Rank
4. Determinants
   1. Computing Determinants, Cofactors, 2X2 and 3X3 Cases
   2. Cramer's Rule
5. Vector Spaces
   1. Definition
   2. n-Dimensional Reals and Subspaces
   3. Linear Independence and Span
   4. Bases and Dimension
6. Optional Topics
   1. Applications of Matrix Algebra, such as computer graphics and animation or cryptography

**Listing of Sections in Departmental Text to be Covered (Name and Author of Text Here):**

**Remarks:** This class is primarily geared towards pre-service middle school mathematics teachers and should be taught with that end in mind. The focus on geometric transformations and fractals is essential to the course. Also, providing a context of applications to motivate topics is also important. In all things, stay focused on the fact that this course should provide them with background and content ideas to be used in the middle school classroom.

**Approximate pace of coverage:**

**Method of Instruction:** Methods may include lecture, group work, discussion of examples, and discussion of computer results.

**Evaluation Procedures:** Possible methods include examinations, quizzes, computer assignments, homework problems, and a final examination.

**Minnesota Transfer Curriculum:** *The following language should appear on each**instructor’s syllabus for the course:*

**Goal 4 under GEP:** ***Mathematics/Logical Reasoning*** – This is a General Education Program course that satisfies the Mathematics/Logical Reasoning requirement of the Minnesota Transfer Curriculum. The goal of this requirement is to increase students' knowledge about mathematical and logical modes of thinking. This will enable students to appreciate the breadth of applications of mathematics, evaluate arguments, and detect fallacious reasoning. Students will learn to apply mathematics, logic, and/or statistics to help them make decisions in their lives and careers. Minnesota's public higher education systems have agreed that developmental mathematics includes the first three years of a high school mathematics sequence through intermediate algebra.

Students will be able to:

1. Illustrate historical and contemporary applications of mathematics/logical systems.

Students learn to write and solve an appropriate linear system in order to solve specific applied problems. Examples include determination of loop currents in a network of electric circuits, formulation of a migration matrix and prediction of subsequent populations (Markov process), the balancing of chemical equations which allow chemically distinct reactions depending on environmental conditions, exploration of fractal geometry, and the modeling of open and closed economic systems. Students will develop an understanding of the effect of shear and scale transformations in a concrete setting such as the application of these transformations to a data matrix in computer graphics.

1. Clearly express mathematical/logical ideas in writing.

As mentioned in the other categories, students will be able to implement and explain, in writing, the processes of using elementary matrices and other matrix algebra concepts to model various real-world phenomena. Additionally, they will be able to interpret, in writing, the solutions to possible results of the solution of linear systems both by using the graphical analogy of the intersection of planes and by examining the system as a collection of vectors spanning a subspace.

1. Explain what constitutes a valid mathematical/logical argument (proof).

Students who take this course will be able to implement and explain in writing the process (including why it works) of using elementary matrices (i.e., elementary row operations) to compute the inverse of a matrix and/or the solution of a given system. Also students will be able to explain the possible results of the solution of linear systems both by using the graphical analogy of the intersection of planes and by examining the system as a collection of vectors spanning a subspace. Student should exhibit knowledge of the case of singular matrices within such a framework.

Additionally, students will learn to implement Cramer’s rule in the case of, minimally, a 3-by-3 matrix. They will gain an understanding of the geometric meaning of the determinant in the context of volumetric change caused by a linear transformation. Students will communicate this information clearly, including the case of a singular matrix. Students gain the ability to interpret the meaning of eigenvalue/eigenvector pairs in a geometrical context. Students study the cases of singular matrices and repeated roots of the characteristic equation.

1. Apply higher-order problem-solving and/or modeling strategies.

Students learn to write and solve an appropriate linear system in order to solve specific applied problems. Examples may include determination of loop currents in a network of electric circuits, formulation of a migration matrix and prediction of subsequent populations (Markov process), the balancing of chemical equations which allow chemically distinct reactions depending on environmental conditions, exploration of fractal geometry, and the modeling of open and closed economic systems. Students will develop an understanding of the effect of shear and scale transformations in a concrete setting such as the application of these transformations to a data matrix in computer graphics.

**MnSCU Learning Outcomes:**

* Students will be able to solve systems of equations using matrix methods, including RREF, inverses, and Cramer's Rule.
* Students will be able to model real-life situations using linear equations and correctly interpret their solutions.
* Students will apply matrix methods to create and analyze fractals using iterated function systems.
* Students will be able to determine whether a given set of vectors is a basis and convert coordinates between bases.
* Students will correctly analyze and classify linear transformations using eigenvalue analysis.

**Last Revised:** Fall 2017 by Felino G. Pascual