NUMERICAL METHODS AND LINEAR ALGEBRA

The University of Toledo

Mathematics & Statistics Department, College of Natural Sciences and Mathematics

MATH2890-002, CRN 15816

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Office Hours: MWF 10:00-11:20 MW 4:30-5:00

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Class Location: ST 0114

Class Day/Time: MWF 9:00-9:50

Credit Hours: 3

Term: Spring,2017

COURSE DESCRIPTION

Topics include: matrices, characteristic roots, solution of linear and nonlinear equations, curve fitting, integration, differentiation and numerical solution of ordinary differential equations.

STUDENT LEARNING OUTCOMES

Below is the list of learning objectives. At least 70% of the course time will be devoted to these essential outcomes. These objectives are listed again in the chronological list of topics at the end of this syllabus.

- Vector Spaces: Use axioms for abstract vector spaces over the real numbers to give examples (and non-examples) of abstract vector spaces such as subspaces of the space of all polynomials.
- Vectors: Utilize algebraic and geometric representations of vectors in $\boldsymbol{R^n}$ and their operations, including addition, scalar multiplication and dot product. Determine the angle between vectors and the orthogonality of vectors.
- Systems of Linear Equations: Solve systems of linear equations using Gauss-Jordan elimination to reduce to echelon form. Solve systems of linear equations using the inverse of the coefficient matrix when possible. Interpret existence and uniqueness of solutions geometrically.
- Matrix Algebra: Perform common matrix operations such as addition, scalar multiplication, multiplication, and transposition.
- Linear Independence: Recognize spanning sets and linear independence for vectors in $\boldsymbol{R^n}$. Prove elementary theorems concerning rank of a matrix and the relationship between rank and nullity.
- Linear Transformations: For a given matrix write the corresponding linear transformation from $\boldsymbol{R^n}$ to $\boldsymbol{R^m}$. Compute a transformations kernel, image, nullity, and the rank. Write a linear transformation in terms of its matrix representation. Compute composition of linear transformations by multiplying their matrix representations.
- Determinants: Compute determinants with co-factor expansion. Describe how row and column operations affect the determinant. Compute the determinant of the product of matrices by multiplying the determinants.
- Eigenvalues and Eigenvectors: Define eigenvalues and eigenvectors geometrically. Use characteristic polynomials to compute eigenvalues and eigenvectors. Use eigenspaces of matrices, when possible, to diagonalize a matrix.
- Dynamical Systems and Differential Equations: Compute Solutions to dynamical systems and initial value problems using Linear Algebra. Interpret phase portraits and their trajectories.

- Orthogonalization: Recognize orthogonal and orthonormal bases, use Gram-Schmidt orthogonalization to find orthogonal and orthonormal bases, find orthogonal complements of sets, and projections of vectors.
- Singular Value Decomposition Compute the singular value decomposition of a matrix. Compute pseudo-inverse

PREREQUISITES

Passing grade in Math 1830, Math 1850, or Math 1920. either prerequisite may be administratively dropped from the class.

TEXTBOOK: Linear Algebra and its applications, 5th edition, by David C. Lay (ISBN-978-0321982384).

POLICY STATEMENT ON NON-DISCRIMINATION ON THE BASIS OF DISABILITY (ADA)

The University is an equal opportunity educational institution. Please read The University's Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.

ACADEMIC ACCOMMODATIONS

The University of Toledo is committed to providing equal access to education for all students. If you have a documented disability or you believe you have a disability and would like information regarding academic accommodations or adjustments in this course please contact the Student Disability Services Office (Rocket Hall 1820; 419.530.4981; studentdisabilitysvs@utoledo.edu) as soon as possible for more information and/or to initiate the process for accessing academic accommodations. For the full policy see: http://www.utoledo.edu/offices/student-disability-services/sam/index.html

ACADEMIC POLICIES:

STUDENT PRIVACY

Federal law and university policy prohibits instructors from discussing a student's grades or class performance with anyone outside of university faculty/staff without the student's written and signed consent. This includes parents and spouses. For details, see the "Confidentiality of Student Records (FERPA)" section of the University Policy Page at http://www.utoledo.edu/policies/academic/undergraduate/index.html

MISSED CLASS POLICY

If circumstances occurring in accordance with The University of Toledo Missed Class Policy (found at http://www.utoledo.edu/policies/academic/undergraduate/index.html) result in a student missing a quiz, test, exam or other graded item, the student must contact the instructor in advance (or as early as possible) in person, provide official documentation to back up his or her absence, and arrange to make up the missed item as soon as possible. If a student can't meet the instructor during the office hours, can make an appointment at a convenient time (or talk to the instructor after the class for simple issues).

ACADEMIC DISHONESTY

Any act of academic dishonesty as defined by the University of Toledo policy on academic dishonesty (found at http://www.utoledo.edu/dl/students/dishonesty.html) will result in an F in the course or an F on the item in question, subject to the determination of the instructor.

IMPORTANT DATES

Final exam date, add/drop, withdraw dates are decided by the university. You can find these dates online yourself at UT website. Dates for quizzes and tests are tentative and subject to change. If there is any change, it will be announced in the class. Students are responsible for all the announcements made in class irrespective of whether a student present or not.

QUIZZES: Jan 23, Jan 30, Feb 13, Feb 20, Feb 27, Mar 27, Apr 3, Apr 10

MIDTERM EXAM: Feb 6, Mar 20, Apr 17

FINAL EXAM: May 2, Tuesday, 10:15-12:15

OTHER DATES

The last day to drop this course is: January 23, 2017
The last day to withdraw with a grade of "W" from this course is: March 24, 2017

GRADING AND EVALUATION

GRADING SCALE

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-
Minimal Percentage Required	93%	90%	87%	83%	80%	77%	73%	70%	67%	63%	60%

GRADING POLICY

Homework: Homework will be assigned regularly but not collected for grading.

8 Quizzes: Only the 7 highest scores are counted. 7 x 4% = 28%

3 Tests: 50 minutes each. 3 x 14% = 42%

Make-ups only in case of an excused absence in accordance with The University of Toledo Missed Class Policy. You must provide official documentation for the absence and contact me *at the earliest possible date.* In particular, in case of a planned absence (such as an athletic competition), contact me *well in advance* of the scheduled exam. Refer MISSED CLASS POLICY discussed earlier in this syllabus.

Final Exam: 120 minutes; comprehensive. 30%

total: 100%

STUDENT SUPPORT SERVICES

Free math tutoring on a walk-in basis is available in the Math Learning and Resources Center located in Rm B0200 in the lower level of Carlson Library (phone ext 2176). The Center operates on a walk-in basis. MLRC hours can be found at http://www.math.utoledo.edu/mlrc/MLRC.pdf

TENTATIVE CLASS SCHEDULE

We will cover the following sections:

1.1 Systems of Linear Equations
1.2 Row Reduction and Echelon Forms
1.3 Vector Equations
1.4 The Matrix Equation
1.5 Solution Sets of Linear Systems
1.7 Linear Independence
1.8 Introduction to Linear Transformations
2.1 Matrix Operations
2.2 The Inverse of a Matrix
2.3 Characterizations of Invertible Matrices
2.4 Partitioned Matrices
2.5 Matrix Factorizations
2.8 Subspaces of $\boldsymbol{R^n}$
2.9 Dimension and Rank
3.1 Introduction to Determinants
3.2 Properties of Determinants
3.3 Cramer's Rule, Volume, and Linear Transformations
4.1 Vector Spaces and Subspaces
4.2 Null Spaces, Column Spaces, and Linear Transformations
4.3 Linearly Independent Sets; Bases
4.4 Coordinate Systems
4.5 The dimension of a vector space
4.6 Rank
5.1 Eigenvectors and Eigenvalues
5.2 The Characteristic Equation
5.3 Diagonalization
5.4 Eigenvectors and Linear Transformation
5.5 Complex Eigenvalues
5.6 Discrete Dynamical Systems (optional)
5.7 Applications to Differential Equations (optional)
6.1 Inner Product, Length, and Orthogonality
6.2 Orthogonal Sets
6.3 Orthogonal Projections
6.4 The Gram-Schmidt Process
6.5 Least-Squares Problems
6.6 Applications to Linear Models
7.1 Diagonalization of Symmetric Matrices
7.2 Quadratic Forms (optional)
7.3 Constrained Optimization (optional)
7.4 The Singular Value Decomposition (optional)

We may cover optional topics if time permits.
Regular attendance is very important to succeed in this course.