MATH 244 Linear Analysis I

1. Catalog Description

MATH 244 Linear Analysis I **4 units**

Prerequisite: MATH 143.

Separable and linear ordinary differential equations with selected applications; numerical and analytical solutions. Linear algebra: vectors in *n*-space, matrices, linear transformations, eigenvalues, eigenvectors, diagonalization; applications to the study of systems of linear differential equations. 4 lectures. Crosslisted as HNRS/MATH 244.

2. Required Background or Experience

Math 143 or equivalent.

3. Learning Objectives

The student should:

a. Develop an understanding of the elementary theory of ordinary differential equations and their solutions in the context of separable and first order linear ordinary differential equations and recognize situations where these equations arise in selected mathematical models.
b. Become familiar with the terminology and methods of solution of higher order linear differential equations, especially methods for constant coefficient homogeneous and forced equations, and understand how these solution methods apply to selected second order linear models.
c. Develop an understanding of linear algebra in Euclidean *n*-space and how vectors and matrices are used to solve systems of equations, both algebraic and differential.

4. Text and References

- Goode and Annin, Differential Equations and Linear Algebra, 4th Ed., Pearson, 2017.

5. Minimum Student Materials

Paper, pencils, and notebook.

6. Minimum University Facilities

Classroom with ample chalkboard space for class use. Use of a computer lab is optional.

7. Content and Method

Topic	Days
Chapter 1. First Order Differential Equations	5
* 1.1 Differential Equations Everywhere	
1.2 Basic Ideas and Terminology	
1.3 The Geometry of First-Order Differential Equations	
1.4 Separable Differential Equations	
* 1.5 Some Simple Population Models	
1.6 First-Order Linear Differential Equations	
1.7 Modeling Problems Using First-Order Linear Differential Equations (see Note)	
* 1.10 Numerical Solution to First-Order Differential Equations	
Chapter 2. Matrices and Systems of Linear Equations	6
2.1 Matrices: Definitions and Notation	
2.2 Matrix Algebra	
2.3 Terminology for Systems of Linear Equations	
2.4 Row-Echelon Matrices and Elementary Row Operations	
2.5 Gaussian Elimination	
2.6 The Inverse of a Square Matrix	
* 2.7 Elementary Matrices and the LU Factorization	
Chapter 3. Determinants	1
3.4 Summary of Determinants	
Chapter 4. Vector Spaces	5
4.1 Vectors in $\mathbb{R}^n$	
* 4.2 Definition of a Vector Space	
4.3 Subspaces	
4.4 Spanning Sets	
4.5 Linear Dependence and Linear Independence	
4.6 Bases and Dimension	
* 4.8 Row Space and Column Space	
* 4.9 The Rank-Nullity Theorem	
Chapter 7. Eigenvalues and Eigenvectors	3
7.1 The Eigenvalue/Eigenvector Problem	
7.2 General Results for Eigenvalues and Eigenvectors	
7.3 Diagonalization	
* 7.4 An Introduction to the Matrix Exponential Function	

Note: In section 1.7, the instructor may choose to focus either on mixing problems or on electric circuits.

Topic	Days
Chapter 8. Linear Differential Equations of Order *n*	7
8.1 General Theory for Linear Differential Equations	
8.2 Constant Coefficient Homogeneous Linear Differential Equations	
8.3 The Method of Undetermined Coefficients	
* 8.4 Complex-Valued Trial Solutions	
8.5 Oscillations of a Mechanical System	
* 8.6 RLC Circuits	
* 8.7 The Variation of Parameters Method	
* 8.8 A Differential Equation with Nonconstant Coefficients	
* 8.9 Reduction of Order	
The principal emphasis in this chapter should be on second-order equations.	
Chapter 9. Systems of Differential Equations	6
9.1 First-Order Linear Systems	
9.2 Vector Formulation	
9.3 General Results for First-Order Linear Differential Equations	
9.4 Vector Differential Equations: Nondefective Coefficient Matrix	
9.5 Vector Differential Equations: Defective Coefficient Matrix	
* 9.6 Variation-of-Parameters for Linear Systems	
* 9.7 Some Applications of Linear Systems of Differential Equations	
* 9.8 Matrix Exponential Function and Systems of Differential Equations	
* 9.9 The Phase Plane for Linear Autonomous Systems	
Total	33

* Sections marked with an asterisk are to be covered at instructor's discretion, as time permits.

Method

Lecture/discussion and regular homework assignments.

8. Methods of Assessment

The primary methods of assessment are essay examinations, quizzes and homework. Typically, there will be one or more hour-long examinations during the quarter, and a required comprehensive final examination. Students are required to show their work, and are graded not only on the correctness of their answers, but also on their understanding of the concepts and techniques.