

Contents

| | | |
|------------------|--|-----------|
| | A WORD FROM THE AUTHORS | vii |
| | WHAT IS LINEAR ALGEBRA? | xv |
| CHAPTER 1 | SYSTEMS OF LINEAR EQUATIONS | 1 |
| 1.1 | Introduction to Systems of Linear Equations | 1 |
| 1.2 | Gaussian Elimination and Gauss-Jordan Elimination | 14 |
| 1.3 | Applications of Systems of Linear Equations | 29 |
| | <i>Review Exercises</i> | 41 |
| | <i>Project 1 Graphing Linear Equations</i> | 44 |
| | <i>Project 2 Underdetermined and Overdetermined Systems of Equations</i> | 45 |
| CHAPTER 2 | MATRICES | 46 |
| 2.1 | Operations with Matrices | 46 |
| 2.2 | Properties of Matrix Operations | 61 |
| 2.3 | The Inverse of a Matrix | 73 |
| 2.4 | Elementary Matrices | 87 |
| 2.5 | Applications of Matrix Operations | 98 |
| | <i>Review Exercises</i> | 115 |
| | <i>Project 1 Exploring Matrix Multiplication</i> | 120 |
| | <i>Project 2 Nilpotent Matrices</i> | 121 |

| | | |
|------------------|--|-----|
| CHAPTER 3 | DETERMINANTS | 122 |
| 3.1 | The Determinant of a Matrix | 122 |
| 3.2 | Evaluation of a Determinant Using Elementary Operations | 132 |
| 3.3 | Properties of Determinants | 142 |
| 3.4 | Introduction to Eigenvalues | 152 |
| 3.5 | Applications of Determinants | 158 |
| | <i>Review Exercises</i> | 171 |
| | <i>Project 1 Eigenvalues and Stochastic Matrices</i> | 174 |
| | <i>Project 2 The Cayley-Hamilton Theorem</i> | 175 |
| | <i>Cumulative Test for Chapters 1–3</i> | 177 |
| CHAPTER 4 | VECTOR SPACES | 179 |
| 4.1 | Vectors in R^n | 179 |
| 4.2 | Vector Spaces | 191 |
| 4.3 | Subspaces of Vector Spaces | 198 |
| 4.4 | Spanning Sets and Linear Independence | 207 |
| 4.5 | Basis and Dimension | 221 |
| 4.6 | Rank of a Matrix and Systems of Linear Equations | 232 |
| 4.7 | Coordinates and Change of Basis | 249 |
| 4.8 | Applications of Vector Spaces | 262 |
| | <i>Review Exercises</i> | 272 |
| | <i>Project 1 Solutions of Linear Systems</i> | 275 |
| | <i>Project 2 Direct Sum</i> | 276 |
| CHAPTER 5 | INNER PRODUCT SPACES | 277 |
| 5.1 | Length and Dot Product in R^n | 277 |
| 5.2 | Inner Product Spaces | 292 |
| 5.3 | Orthonormal Bases: Gram-Schmidt Process | 306 |
| 5.4 | Mathematical Models and Least Squares Analysis | 320 |
| 5.5 | Applications of Inner Product Spaces | 336 |
| | <i>Review Exercises</i> | 352 |
| | <i>Project 1 The QR-Factorization</i> | 356 |
| | <i>Project 2 Orthogonal Matrices and Change of Basis</i> | 357 |
| | <i>Cumulative Test for Chapters 4 and 5</i> | 359 |

| | | |
|------------------|--|-----|
| CHAPTER 6 | LINEAR TRANSFORMATIONS | 361 |
| 6.1 | Introduction to Linear Transformations | 361 |
| 6.2 | The Kernel and Range of a Linear Transformation | 374 |
| 6.3 | Matrices for Linear Transformations | 387 |
| 6.4 | Transition Matrices and Similarity | 399 |
| 6.5 | Applications of Linear Transformations | 407 |
| | <i>Review Exercises</i> | 416 |
| | <i>Project 1 Reflections in the Plane (I)</i> | 419 |
| | <i>Project 2 Reflections in the Plane (II)</i> | 420 |
| CHAPTER 7 | EIGENVALUES AND EIGENVECTORS | 421 |
| 7.1 | Eigenvalues and Eigenvectors | 421 |
| 7.2 | Diagonalization | 435 |
| 7.3 | Symmetric Matrices and Orthogonal Diagonalization | 446 |
| 7.4 | Applications of Eigenvalues and Eigenvectors | 458 |
| | <i>Review Exercises</i> | 474 |
| | <i>Project 1 Population Growth and Dynamical Systems (I)</i> | 477 |
| | <i>Project 2 The Fibonacci Sequence</i> | 478 |
| | <i>Cumulative Test for Chapters 6 and 7</i> | 479 |
| CHAPTER 8 | COMPLEX VECTOR SPACES (online)* | |
| 8.1 | Complex Numbers | |
| 8.2 | Conjugates and Division of Complex Numbers | |
| 8.3 | Polar Form and DeMoivre's Theorem | |
| 8.4 | Complex Vector Spaces and Inner Products | |
| 8.5 | Unitary and Hermitian Matrices | |
| | <i>Review Exercises</i> | |
| | <i>Project Population Growth and Dynamical Systems (II)</i> | |

CHAPTER 9 **LINEAR PROGRAMMING (online)***

- 9.1 **Systems of Linear Inequalities**
- 9.2 **Linear Programming Involving Two Variables**
- 9.3 **The Simplex Method: Maximization**
- 9.4 **The Simplex Method: Minimization**
- 9.5 **The Simplex Method: Mixed Constraints**

Review Exercises

Project Cholesterol Levels

CHAPTER 10 **NUMERICAL METHODS (online)***

- 10.1 **Gaussian Elimination with Partial Pivoting**
- 10.2 **Iterative Methods for Solving Linear Systems**
- 10.3 **Power Method for Approximating Eigenvalues**
- 10.4 **Applications of Numerical Methods**

Review Exercises

Project Population Growth

APPENDIX **MATHEMATICAL INDUCTION AND OTHER
FORMS OF PROOFS**

A1

ONLINE TECHNOLOGY GUIDE (online)***ANSWER KEY**

A9

INDEX

A59

* Available online at college.hmco.com/pic/larsonELA6e.