MAT 342 Course Objectives, Fall 2001

Here is a list of things you should know and procedures which you should know how to do. Note there is some overlap between various items: putting a matrix into Reduced Row Echelon Form is used in several “applications” listed later. After each item is the section in which the information can be found.

Matrices and Systems of Linear Equations
1. Be able to rewrite linear equations in matrix form [1.1]
2. Perform row operations on a matrix (or an augmented matrix) [1.1]
3. Put a matrix into Row Echelon Form [1.2]
4. Put a matrix into Reduced Row Echelon Form [1.2]
5. Determine which variables of a system of linear equations are lead variables and which are free variables [1.2]
6. Solve for the lead variables in terms of the free variables [1.2]
7. Find all solutions to a system of linear equations [1.2]

Matrix Algebra
8. Add, subtract, multiply two matrices, multiply a matrix by a scalar [1.3]
9. Find the transpose of a given matrix [1.3]
10. Properties of addition, multiplication, scalar multiplication, and transposition of matrices [1.3]
11. Significance of the Identity Matrix and the Zero Matrix [1.3]
12. Find the inverse of a matrix, if it has one [1.4]
13. Solve for a matrix \(X\) in a matrix equation [1.3]
14. Conditions which are equivalent to a matrix being invertible [various]

Elementary Matrices
15. Determine which row operation an Elementary Matrix represents [1.4]
16. Find an Elementary Matrix which corresponds to a row operation [1.4]
17. Relationship between Elementary Matrices and row operations [1.4]

Determinants
18. What the determinant is and when it is zero [2.1, 2.2]
19. Expansion of a row by minors [2.1]
20. Use row reduction to find the determinant of a matrix [2.2]
21. Formulas for the determinant of the product of two square matrices, the determinant of the transpose of a matrix, and a scalar multiple of a matrix [2.2]
22. The determinant of a triangular matrix [2.2]
23. Cramer’s Rule for \(Ax = b\) [2.3]
24. Cramer’s Rule for the inverse of a matrix (based on the adjoint of a matrix) [2.3]

Vector Spaces
25. Examples [3.1]
26. Determine whether a given set is a subspace of a vector space (Subspace Test) [3.2]
27. When a set of vectors spans a set \(S\) [3.2]
28. Use row reduction to determine whether a set of vectors spans \(R^n\) [3.2]
29. Definition of a linearly independent set of vectors [3.3]
30. Use row reduction to determine whether a set of vectors is linearly independent [3.3]
31. Determine whether a set of vectors is a basis for some subspace [3.4]
32. Find the dimension of a vector space or a subspace [3.4]
33. Find the coordinates of a vector with respect to some ordered basis [3.5]
34. Convert coordinates of a vector with respect to an ordered basis \(F_1\) to another ordered basis \(F_2\) [3.5]
Vector Spaces Associated With A Matrix $A$

35. Find a basis for the null space of a matrix $A$ [3.2]
36. Find a basis for the row space of a matrix $A$ [3.6]
37. Find a set of rows of a matrix $A$ that is a basis for its space [3.6]
38. Find a basis for the column space of a matrix $A$ [3.6]
39. Find a set of columns of a matrix $A$ that is a basis for its column space [3.6]
40. Find the rank and nullity of a matrix $A$ [3.6]

Linear Transformations

41. Determine whether a function is a linear transformation [4.1]
42. Find a matrix which represents a linear transformation with respect to two bases $F_1$ and $F_2$ [4.2]
43. When a matrix $A$ is similar to another matrix $B$ [4.3]
44. Show that if $A$ is similar to $B$, then $C$ is similar to $D$ (with $C = A^2$ and $D = B^2$, for instance) [4.3]

Orthogonality

45. Definition of an inner product [5.4]
46. Use the scalar product to determine whether two vectors are orthogonal (perpendicular) [5.1]
47. Find the projection of a vector $\vec{u}$ in the direction of $\vec{v}$ [5.1]
48. Find the length of a vector using an inner product [5.1]
49. Find a vector in the direction of $\vec{u}$ which has a length of 1 [5.1]
50. Find the residue vector $\vec{r}$ [5.1]
51. Find the orthogonal complement of a subspace $S$ [5.2]
52. Solve the least squares problem: Given a subspace $S$ and a vector $\vec{x}$, find the vector in $S$ closest to $\vec{x}$. [5.3]
53. Use a least squares to solution to find the best-fitting curve (line, parabola, etc) to a given set of data [5.3]
54. Determine whether a set of vectors is an orthonormal set [5.5]
55. Find the coordinates of a vector with respect to a basis which is orthonormal [5.5]
56. Find the inner product of two vectors, if their coordinates with respect to an orthonormal basis are known [5.5]
57. Use Parseval’s Formula to find the length of a vector [5.5]
58. Given a set of vectors spanning $S$, find an orthonormal set which spans $S$ [5.6]

Eigenvalues

59. Definition of eigenvalues, eigenvectors, and the eigenspace of a matrix [6.1]
60. Show that if $\lambda$ is an eigenvalue of the matrix $A$, then $\lambda'$ is an eigenvalue of $A'$ (for instance, $\lambda^2$ is an eigenvalue of $A^2$) [6.1]
61. Find eigenvalues of a small matrix or a triangular matrix [6.1]
62. Find the eigenvectors belonging to a certain eigenvalue [6.1]
63. Determine whether a matrix is similar to a diagonal matrix [6.3]
64. Calculate powers of and the inverse of a diagonalizable matrix [6.3]

MAT 342 Website: http://math.la.asu.edu/~checkman/342/