Helwan University
Faculty of Computers and Information

Course Syllabus

Department of Computer Science
MA214 Linear Algebra

Office Hours: See webpage.

Prerequisites: Elementary calculus is recommended but not necessary.

Objectives:

- Developing rigorous treatment.
- Developing mathematical foundations to many courses and areas!!.
- Building intuition.
- Linking to CS applications (e.g., Pattern Recognition, Image Processing, etc.)
- Introducing students to "Mathematical Computing" (we will use "Sage")

Text: Strang, G., 2003. Introduction to linear algebra, 3rd Edition. Wellesley-Cambridge, Wellesly, MA

Assignments: Assignments will include both, problems and computer exercises. Either Matlab or R is preferable for solving the computer exercises. **No late assignments please**.

Grading Policy: 60% of the grade will be on the final exam, 20% on quizes, and 20% on midterm exam; **So, there is no credit for solving homeworks; however you have to solve them!**

Course Syllabus:

1. Introduction to Vectors: Vectors and Linear Combinations, Lengths and Dot Products, Matrices
2. Solving Linear Equations: Vectors and Linear Equations, The Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices, Elimination = Factorization: A = LU, Transposes and Permutations
3. Vector Spaces and Subspaces: Spaces of Vectors, The Nullspace of A: Solving Ax = 0 and Rx = 0, The Complete Solution to Ax = b, Independence, Basis and Dimension, Dimensions of the Four Subspaces
4. Orthogonality: Orthogonality of the Four Subspaces, Projections, Least Squares Approximations, Orthonormal Bases and Gram-Schmidt
5. Determinants: The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes
6. Eigenvalues and Eigenvectors: Introduction to Eigenvalues, Diagonalizing a Matrix, Systems of Differential Equations, Symmetric Matrices, Positive Definite Matrices
7. The Singular Value Decomposition (SVD): Image Processing by Linear Algebra, Bases and Matrices in the SVD, Principal Component Analysis (PCA by the SVD), The Geometry of the SVD
8. Linear Transformations: The Idea of a Linear Transformation, The Matrix of a Linear Transformation, The Search for a Good Basis
9. Complex Vectors and Matrices: Complex Numbers, Hermitian and Unitary Matrices, The Fast Fourier Transform
10. Applications: Graphs and Networks, Matrices in Engineering, Markov Matrices, Population, and Economics, Linear Programming, Fourier Series: Linear Algebra for Functions, Computer Graphics, Linear Algebra for Cryptography
11. Numerical Linear Algebra: Gaussian Elimination in Practice, Norms and Condition Numbers, Iterative Methods and Preconditioners
12. Linear Algebra in Probability & Statistics: Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities, Multivariate Gaussian andWeighted Least Squares