EL-716: Linear Algebra and Convex Optimization

Linear equations and matrices: Systems of linear equations, Homogeneous systems, Matrix algebra.

Vector Spaces: Real vector spaces, Euclidean space, Subspaces, Span, Range and Null space Linear dependence and Linear independence, Basis and Dimension, Rank of a Matrix, Rank Nullity theorem.

Orthogonality: Orthogonality, Inner product spaces, Orthogonality, Gram-Schmidt process, Norms, Orthonormal basis.

Eigen values and Eigen vectors: Eigenvalue-Eigenvector pairs, Characteristic equation, Eigenspaces and geometric multiplicity.

Linear Transformations: Kernel and range, Matrix of linear transformation, Operations on linear transformations, Dual Spaces.

General Matrices: The matrices AAT and ATA, Singular Values, Singular Value Decomposition, Pseudo-inverse and the Geometry of Pseudo-inverse.

Introduction to Convex Optimization: Convex sets, convex functions, Convexity, Conjugate function, conjugate sets, Hyperplanes, Norm-balls, Formulation of convex optimization problems.

Duality Theory: Weak and strong duality, Lagrangian dual function, KKT conditions.

Convex optimization algorithms: Barrier interior point method, Primal-dual interior point methods, Conjugate gradient-projection method.

Text Book:

1. Gilbert Strang, Introduction to Linear Algebra, Fourth Edition, Wellesley-Cambridge Press, Wellesley, MA, 2009, ISBN 978-09802327-14
2. Boyd, Stephen P.; Vandenberghe, Lieven (2004). Convex Optimization, Cambridge University Press.ISBN 978-0-521-83378-3. Retrieved October 15, 2011.
3. Edwin K. P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Fourth Edition, Wiley-India, 2013, ISBN: 978-1-118-27901-4.

Reference Books:

1. Stephen H. Friedberg and Arnold J. Insel, Linear Algebra, 4th Edition, Pearson, 2003.
2. Dimitri P. Bertsekas, Convex Optimization Theory Athena Scientific, 2009.
3. Nesterov, Introductory Lectures on Convex Optimization: A Basic Course, Springer, 2003.
4. David G. Luenberger, Optimization by Vector Space Methods, Wiley, 1997.
5. Ben-Tal and Nemirovski, Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications, MPS-SIAM Series on Optimization, 2001.