Department of Mathematics & Statistics, KFUPM

Math 557 Syllabus (Term 211)

Instructor: Khaled M. Furati

Course Title: Applied linear algebra

Course Description: Basics concepts from linear algebra and numerical analysis. Direct methods for large, sparse linear systems, Cholesky and LU factorizations. Regularization of ill-conditioned least squares problems. SVD and QR factorizations. Sensitivity and conditioning of linear systems and least square problems. Stationary and non-stationary iterative methods, multigrid methods. Matrix theory including spectral decompositions, and eigenvalue perturbation theory. Eigenvalue and QR algorithm, and computations of SVD. Applications.

Prerequisite: Graduate standing

Textbook: Numerical Linear Algebra, Lyche, 2020

References: Numerical Linear Algebra, Trefethen, 1997.
Numerical Linear Algebra, Lyton and Sussman, 2014 (2020)
Linear Algebra and Matrix Computations, Xue, 2020

Learning Outcomes: Upon completion of this course, students will be able to:

1. Apply fundamental numerical linear algebra concepts
2. Estimate stability of solutions to linear algebraic equations & eigenvalue problems
3. Utilize factorizations for efficiently solving linear systems and least squares problems
4. Use the underlying principles of iterative algorithms for computing and selecting eigenvalues and finding singular values
5. Estimate the speed of convergence and computational complexity of the selected numerical algorithms

Assessment Homework, Project, Midterm Exam and Final Exam.

WK	Date	Part	Ch	Topics
1	Aug 29-Sep 2	**	1	Review of linear algebra
2	Sep 05-09	I LU & QR factorization	2	Example: Diagonally dominant tridiagonal matrices
3	Sep 12-16		3	Gaussian elimination and LU factorization
4	Sep 19-23		4	LDL* factorization and positive definite matrices
5	Set 26-30		5	Orthonormal and unitary transformations
6	Oct 03-07	II Eigenpairs & singular values	6	Eigenpairs and similarity transformations
7	Oct 10-14		7	Singular value decomposition
8	Oct 17-21	III Matrix norms & Least squares	8	Matrix norms and Perturbation Theory
9	Oct 24-28		9	Least squares
10	Oct 31-Nov 04	V Iterative methods for large linear systems	12	Classical iterative methods
11	Nov 07-11		13	Conjugate gradient method
12	Nov 14-18	VI Eigenvalues and eigenvectors	14	Numerical eigenvalue problems
13	Nove 21-25		15	The QR algorithm
B	Nov 28-Dec 02	Break		
14	Dec 05-09	*********		Projects prentations
15	Dec 12-16			Review