

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Department of Mathematics & Statistics
MATH 690- Special Topics in Mathematics (Numerical Linear Algebra)
Semester: 202

Instructor: Dr. Manal Alotibi

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Course times and location: UT 13:00-14:15 pm Building 42- Classroom 213

Office hours: Sunday and Tuesday, 10:00 am -13:00 pm (or set an appointment if needed)

Course Description:

Linear algebra from a numerical solution perspective. Matrix factorizations, linear least squares, Gram-Schmidt orthogonalization, conditioning and stability, system of equations, eigenanalysis, singular value decomposition, proper orthogonal decomposition, iterative methods, GMRES, conjugate gradient, Preconditioning.

Objectives

On completion of the course, students will be able to

- 1- construct some key matrix factorization using elementary transformations
- 2- choose an appropriate numerical method to solve linear systems, least squares problems, and the eigenvalue problem
- 3- evaluate the efficiency and numerical stability of different algorithms for solving linear systems, least squares problems, and the eigenvalue problem.
- 4- Apply some numerical reduction techniques such as POD for solving linear system.
- 5- Implement the algorithms for solving linear systems, least squares problems, and the eigenvalue problem using suitable software.

Pre-request: Graduate Standing

Required knowledge: Programming skills with MATLAB or Python. Basic knowledge in numerical analysis

Textbook:

Lloyd Trefethen and David Bau. *Numerical Linear Algebra*. Society for industrial and applied mathematics, USA. This book is available as a free pdf download from this [link](#)

Other useful references

1. Golub and Van Loan, Matrix Computations, 3rd edition. Here is the [link](#)
2. W. Layton and M. Sussman, Numerical Linear Algebra. Here is the [link](#)
3. Nicholas J. Higham. Accuracy and Stability of Numerical Algorithms Here is the [link](#)

Grading Policy:

- Exam 1:20% (week # 7)
- Exam 2: 20% (week # 13)
- Homework: 20%
- Programming Assignments: 10%
- Final Exam 30% (comprehensive; date and location: to be announced)

Homework Policy:

Homework should be submitted in MS as in pdf format by the midnight of the due date. Each late submission will be penalized by 5%. Use the following subject line to submit your homework:

MATH 690 HOMEWORK [NUMBER] - [NAME - KFUPM STUDENT ID]

In case you do not use the above format, I might miss your submission and you might be penalized for late submission.

Attendance Policy:

Attendance is a University Requirement. If you miss 9 or more classes without an official excuse, you will be given a DN grade.

List of topics	Contact hours	Number of weeks
Fundamentals: computing with matrices, norms, SVD	6	2
QR Factorization: Projectors, QR factorization, Gram-Schmidt orthogonalization, Least square problems	9	3
Conditioning and stability: conditioning and condition numbers, machine precision, stability of an algorithm.	9	3
System of Equations: Gaussian Elimination, Pivoting, Cholesky Factorization.	3	1
Eigenvalue problem: power iteration, QR, SVD, POD	9	3
Iterative methods: Arnoldi, GMRES, conjugate gradient	9	3
	45	15