جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Numerical Linear Algebra - AMCS 251

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 251
Course Title	Numerical Linear Algebra
Academic Semester	Fall
Academic Year	2019/2020
Semester Start Date	08/25/2019
Semester End Date	12/10/2019
Class Schedule (Days & Time)	04:00 PM - 05:30 PM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Matteo Parsani	Matteo.Parsani@kaust.edu.sa	+966128080678	0140 (Level 0), 1, Al-Khawarizmi (bldg. 1)	By appointment (e-mail or ask before or after the class). Thanks.

Teaching Assistant(s)

Name	Email
Mohammed Sayyari and another one Linda Alzaben.	mohammed.alsayyari@kaust.edu.sa linda.alzaben@kaust.edu.sa

Course Information

Comprehensive Course Description	Numerical analysis describes the construction and analysis of efficient discrete algorithms to solve continuous problems using large amounts of data. It represents the basis for the field of numerical analysis, and should therefore be learned and mastered as early as possible. We will cover: 1. Fundamentals: computing with matrices, execution time, norms, SVD 2. Factorization: Cholesky decomposition; QR decomposition 3. Least square: normal equation, orthonormal equation 4. Error analysis: error measures, conditioning of a problem, machine precision, stability of an algorithm 5. Eigenvalue problem: power iteration, QR, SVD 6. Iterative methods: Arnoldi, GMRES, conjugate gradient
Course Description from Program Guide	Linear algebra from a numerical solution perspective.Singular Value Decomposition, matrix factorizations, linear least squares, Gram-Schmidt orthogonalization, conditioning and stability, eigenanalysis, Krylov subspace methods and reconditioning, and optimization and conjugate gradient methods.

Goals and Objectives	This course will introduce you to the essential problems and solution techniques of numerical linear algebra, including square linear systems, eigenvalue problems, and least squares. When the first computers became available for solving linear algebraic systems, the experts predicted that computed solutions of large systems would be useless due to the amplification of errors. Nevertheless, numerical solution of very large linear systems has become an essential tool underlying things that we all use every day in computational science ane engineering. In this course, you will learn how those solutions are computed. On completion of the course, students will be able to -construct some key matrix factorization using elementary transformations -choose an appropriate numerical method to solve linear systems, least squares problems, and the eigenvalue prpblem -evaluate and compare the efficiency and numerical stability of different algorithms for solving linear systems, least squares problems, and the eigenvalue prpblem -write programs for the solution of "simple and small" linear systems, least squares problems, and the eigenvalue prpblem
Required Knowledge	The students should have the basic knowledge in linear algebra and numerical analysis. Programming skills with Python or Matlab or Julia or any other programming language which allows to solve numerically a problem an visualize the solution is also required. For a review of undergraduate linear algebra, I also recommend: recorded course by Professor Gil Strang
Reference Texts	The main book of the course will be: Lloyd Trefethen and David Bau. *Numerical Linear Algebra*. Society for Industrial and Applied Mathematics,USA. However, several lectures will follow closely the following reference: Folkmar Bornemann. *Numerical Linear Algebra: A Concise Introduction with MATLAB and Julia* (Springer Undergraduate Mathematics Series). Springer International Publishing. However, I also highly recommend to read and consider 1. Timothy A. Davis. *Direct Methods for Sparse Linear Systems*. Society for Industrial and Applied Mathematics, USA. 2. Biswa Nath Datta. *Numerical Linear Algebra and Applications*. Society for Industrial and Applied Mathematics,USA. 3. Nicholas J. Higham. *Accuracy and Stability of Numerical Algorithms*. Society for Industrial and Applied Mathematics, USA. 4. Klein, Philip. *Coding the Matrix: Linear Algebra through Computer Science Applications*. Newtonian Press.
Method of evaluation	**33.00**% - Midterm exam **28.00**% - Homework /Assignments **33.00**% - Final exam **5.00**% - Attendance and Participation
Nature of the assignments	At the end of each week, homework will be assigned and will usually be due every Thursday or second Thursday. You are allowed to discuss your solutions with other students but **all work that you turn in must be your own**, and you must understand it completely. If there is doubt you may be asked to explain your solution in class. Homework problems will include proofs, derivations, calculations, and programming. For homework problems that require programming, you must turn in the code used to compute your solutions. However, **your code and plots are not the answer** and will not be graded; **they are merely a supplement to your thoughtful written explanations.** It is essential that you devote substantial time to the reading, since I will not cover all topics in class. Instead, you should come to class prepared to ask questions.

Course Policies	If you have a personal activity, family, or religious conflict with the course schedule, you can expect to be heard sympathetically. Please contact me by the end of the second week of the term to discuss appropriate accommodations for any conflicts that can be foreseen. For illness-related absences, there are standard procedures to follow. Late work in this course will receive no credit. You should always turn in what you have completed by the deadline. If there are extenuating circumstances, come talk to me before the deadline.
Additional Information	We will use Piazza for posting homeworks, announcements, etc.

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 08/26/2019 Thu 08/29/2019	See syllabus on piazza.com.
2	Mon 09/02/2019 Thu 09/05/2019	See syllabus on piazza.com.
3	Mon 09/09/2019 Thu 09/12/2019	See syllabus on piazza.com.
4	Mon 09/16/2019 Thu 09/19/2019	See syllabus on piazza.com.
5	Mon 09/23/2019 Thu 09/26/2019	See syllabus on piazza.com.
6	Mon 09/30/2019 Thu 10/03/2019	See syllabus on piazza.com.
7	Mon 10/07/2019 Thu 10/10/2019	See syllabus on piazza.com.
8	Mon 10/14/2019 Thu 10/17/2019	See syllabus on piazza.com.
9	Mon 10/21/2019 Thu 10/24/2019	See syllabus on piazza.com.
10	Mon 10/28/2019 Thu 10/31/2019	See syllabus on piazza.com.
11	Mon 11/04/2019 Thu 11/07/2019	See syllabus on piazza.com.
12	Mon 11/11/2019 Thu 11/14/2019	See syllabus on piazza.com.
13	Mon 11/18/2019 Thu 11/21/2019	See syllabus on piazza.com.
14	Mon 11/25/2019 Thu 11/28/2019	See syllabus on piazza.com.
15	Mon 12/02/2019 Thu 12/05/2019	See syllabus on piazza.com.
16	Mon 12/09/2019	See syllabus on piazza.com.

Note

The instructor reserves the right to make changes to this syllabus as necessary.