Numerical Linear Algebra (Math 442/642)

Instructor: Dr. Scott Sarra
Office Hours: by appointment on TR from 12:15 to 2:00 and 3:15 to 5:00 in ML 110
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Textbooks: ~~*Numerical Analysis* (2nd Edition) by Tim Sauer, ISBN: 0321783670~~
Numerical Mathematics and Computing by Kincaid and Chaney ISBN: 1133103715

Supplemental reading:

- Numerical Linear Algebra, L. N. Trefethen and D. Bau, ISBN 089871487
- Numerical Linear Algebra and Applications, B. Datta. ISBN 978-0-898716-85-6
- Accuracy and Stability of Numerical Algorithms, N. Higham, ISBN 0898715210
- Matrix Analysis and Applied Linear Algebra, C. Meyer, ISBN 0-89871-545-0

Course Learning Outcomes:

After completing the course the student will 1) have gained a deeper understanding of basic concepts from numerical linear algebra that were introduced in MTH 443/643 such as the conditioning of problems and backward error analysis, 2) will be introduced to an important part of more advanced numerical linear algebra - orthogonal numerical linear, 3) will understand how severely ill-conditioned problems can be solved more accurately by using regularization techniques, 5) will have learned how symmetries and other structure of mathematical problems can be used to develop more efficient algorithms, 6) will be exposed to and complete a project in a current research area in numerical analysis, 7) will have gained experience in doing a literature search, 8) will have written a paper that was typeset using LaTeX, 9) will have had the experience of giving a presentation on a mathematical topic, 10) will have gained experience in using mathematical software, and 11) will have experience writing mathematical software.

Prerequisites: MTH 443/643.

Grading: 70% homework and 30% final project

Class Attendance:

In 400/600 level classes, attendance at every class is expected. I do not "read the text book" to the class during lectures. The material presented in lectures is meant to supplement the text book.

Homework:

Approximately 6 homework sets will be given in 2 to 3 week intervals. All solutions must be turned in in hard copy form. Electronic versions will not be accepted. A followup oral questioning may be given after HW solutions are submitted. This is to both clear up any misunderstandings on the HW solutions and to ensure that the solutions submitted are indeed the work of the particular student. HW due dates may be extended due to rare circumstances for the class as a whole, but not for individuals.

Computer Programming:

An essential part of Numerical Mathematics is implementing algorithms on a computer. The HW sets and the final project will require some (relatively) simple computer programs to be written. Computer languages that are appropriate for and that are commonly used in scientific computing include Fortran, C/C++, Python, and Julia. Python will be the language that is primarily used in class examples. Python is also suggest for use in HW problems and projects since you should be familiar with it from CS 205 which is a prerequisite to this class. However, any other (appropriate) language of your choice may be used.

Collaboration policy:

Collaboration on HW sets is not only allowed, but is encouraged. Each student must write up and turn in their own solutions. For problems involving computer programs, a listing of the computer code and its output must be submitted. If the computer program is a collaborative effort, each student in the group must separately type in and execute the program and then generate printed code and output. In addition to working with other students in the class, you are encouraged to use resources such as text books other than the official class text, journal articles, and internet searches. No matter whom you talk to or what you read, HW solutions should be written up on your own, without having the solutions produced by the entire group or other source in front of you. There is a huge difference between collaborating and copying. Copied HW solutions will be given zero credit. Copied HW solutions are usually very easy to identify. Even if copied solutions can not be identified in written form, the fact that they were copied always comes out in the follow-up oral questions on the HW.

Final Project:

The final project is to write a 8 to 25 page paper (typed using LaTeX), surveying an interesting numerical algorithm not covered in the course. The paper should be written for a target audience of your classmates in the course. The paper should include the following: 1) numerical results (produced from computer code that you write) from applying the algorithm to a model problem, 2) proofs of theoretical properties (stability, convergence rate, etc.) of the algorithm and numerical examples illustrating and verifying the properties, 3) a comparison to a competing algorithm for solving the same problem, 4) references (in a bibliography) to published literature (journal articles and books - not web pages) that document the development of the method as well as subsequent improvements of the method. The paper will be summarized in a 10 to 15 minute presentation to the class. The project should not be started on until a one page proposal that outlines the work to be done in the project has been approved. The proposal should be submitted and approved no later than the end of the fourth week of class.

Instead of picking a numerical algorithm, the subject of the final project may instead be the subject of a peered reviewed journal publication in the area of numerical linear algebra.

Due dates/Makeup exams

If you are unable to take an exam due to an excused absence, you must contact me prior to the exam time and furnish the proper written verification of the absence as defined by the MU undergraduate catalog in order to take a make-up exam.

Documented learning disabilities:

Accommodations will be made to assist students with documented learning disabilities. Students should make arrangements with the Help center or other appropriate campus origination to provide the instructor with a notice of accommodation.