Numerical Methods for Digital Computers

CS 3513 — Dr. Douglas R. Heisterkamp
NH 241 — NH 321
4:30-7:10 p.m. Wednesday — 918-200-9377
Spring 2021 — doug@cs.okstate.edu

Course Catalog Description: Prerequisites: MATH 2153, MATH 3013 (concurrent enrollment is OK, substituting MATH 3263 or MATH 2233 is OK), and a knowledge of programming. Errors, floating point numbers and operations, interpolation and approximation, solution of nonlinear equations and linear systems, condition and stability, acceleration methods, numerical differentiation and integration.

Course Objective: This course teaches numerical methods for the approximate solution of continuous mathematical problems in linear algebra and calculus. The material is intended to be useful in the solution of problems in engineering, statistics, and the sciences.

Primary Texts (require): Justin Solomon, *Numerical Algorithms: Methods for Computer Vision, Machine Learning, and Graphics*, CRC Press, 2015. ISBM: 978-1-4822-5188-3. Availabe as a pdf from `https://people.csail.mit.edu/jsolomon/share/book/numerical_book.pdf`. A copy is also on canvas.

Zoom Office Hours: 3:00-4:00 p.m. Tuesday, Wednesday, and Thursday
See canvas for zoom invite for office hours.
Other times available by appointment.

Grading:

Online Quizzes	10%
Assigned work	40%
Midterm Exam	25%
Final Exam	25%

Grading Scale: for score x in

$90\% \leq x$	A
$80\% \leq x < 90\%$	B
$70\% \leq x < 80\%$	C
$60\% \leq x < 70\%$	D
$x < 60\%$	F

Dates:

Wellness day – class does not meet	:	February 3
Midterm Exam	:	**March 17**
Final Exam	:	**May 5, 6:00-7:50 p.m.**

Examinations: During an examination period, no communication of any kind about the exam (except with the instructor or proctor) is allowed. In you are not able to take the exam you will need to schedule the exam with OSU testing center (they will charge for proctoring).

Online Quizzes: quizzes will be posted on canvas. Typically will be due at 11:59 on Wednesdays. You may take each quiz three times, with the highest score used for grading. Quizzes will be available for two weeks after initial due date with no late penalty.

Assigned work: Programs may be written in any language (except matlab) as long as the TA and the professor are able to build and execute from source code. Examples for class will be in C++ or Python. If in doubt, contact the instructor before the due date to verify that the programming environment is acceptable. If assignments are turned in late, they lose a percentage of their graded point values according to the following schedule:

Programming Problems		
On time	:	0%
6 days	:	10%
12 days	:	30%
18 days	:	50%
> 18 days	:	100%

Written and Programming Exercises		
On time	:	0%
96 hours	:	25%
More 96 hours	:	100%

Assignments will be due at 11:59 p.m. on Fridays. Assignments may be turned in using the assignment dropbox on canvas or using your individual git repository. Please use a high resolution black and white scan for hand written exercises. Written exercises may also be turned during class. The base URL for the course git repository is `https://cs.okstate.edu/git/cs3513/course`. The URL for individual class repository is `https://cs.okstate.edu/git/cs3513/class/user-id`, where user-id is replaced by your csx user id. Note that the git repositories uses the same user id and password as csx. If you have not used csx in your previous courses, see users names and passwords section of `http://www.cs.okstate.edu/loggingon.html`. More information on using git will be provide during the semester.

Collaboration: Discussion of concepts, ideas, and techniques is allowed. After discussion, each student must write up his/her own solution. Copying another person's work, in part or whole, is not allowed. Giving another student your work, in part or whole, is considered cheating as well. If you are unsure whether your collaboration is acceptable, speak with the instructor in advance. Any violation of academic integrity would result in a undroppable grade of zero for that assignment and an additional reduction of one letter grade in the course and a report to the university administration. Major violations will result in a grade of F!.

Disabilities act: If any student feels that he/she has a disability and needs special accommodations of any nature whatsoever, the instructor will work with you and the Office of Disabled Student Services to provide reasonable accommodations to ensure that you have a fair opportunity to perform in this class. Please advise the instructor of such disability and the desired accommodations at some point before, during, or immediately after the first scheduled class period.

Syllabus Attachment: See `https://academicaffairs.okstate.edu/site-files/documents/spring-2021-syllabus-attachment-1-6-21.pdf` for Stillwater's syllabus attachment. Both Stillwater and Tulsa's syllabus attachments will also be uploaded to D2L.

All students are expected to follow university COVID-19 guidelines as they exist at the beginning of the semester and adapt to them as they may change during the semester.

The in person lectures will also be available live on zoom. The zoom invites will be posted on canvas. The lectures will be recorded and made available on canvas. Warning: recorded lectures may only be available for two weeks if storage becomes a problem.

Tenative Schedule

Date	Textbook	Topics
1/20	notes, 2.2	Background
1/27	2.1, 2.3	Floating point number systems
2/3	—	*Wellness day – no lecture*
2/10	8.18.3	Root-finding
2/17	9.1-9.3	Unconstrained optimization
2/24	3.1-3.5	Linear systems and LU decomposition, pivoting
3/3	4.1-4.3	Linear least squares, sensitivity, conditioning
3/10	5.1-5.6	QR decomposition, Gram-Schmidt orthogonalization
3/17	—	midterm exam
3/24	11.1-11.3	Iterative linear solvers
3/31	6.1-6.5	Eigenvalues, Eigenvectors
4/7	7.1-7.2	Singular value decomposition
4/14	13.1-13.2	Interploation
4/21	14.1-14.3	Integration and differentiation
4/28	15.1-15.4	Ordinary Differential Equations
5/5	—	final exam, 6:00-7:00 p.m.

Additional readings (optional): the following textbooks have been used in the past for this course. If you are having problems understanding a topic in the current textbook, I would encourage you to read the presentation in another book.

- Jaan Kiusalaas, *Numerical Methods in Engineering with Python 3*, 3nd edition, Cambridge University Press, 2013. ISBN: 978-1-107-03385-6.
- Brian Bradie *A Friendly Introduction to Numerical Analysis*, Pearson Prentice Hall, 2006. ISBN: 0-13-013054-0
- *A First Course in Numerical Methods* by Uri Ascher and Chen Greif, SAIM, 2011. ISBN: 978-0-898719-97-0.
- John Chandler, *Elements of Numerical Computation*, These notes can be downloaded from `http://cs.okstate.edu/jpcfiles/Numerical.dir`. The pre-appendices provide useful background information.