MATH 693A ADVANCED NUMERICAL METHODS: COMPUTATIONAL OPTIMIZATION

FALL 2024
Schedule Number: 9238

COURSE INFORMATION

Class Days: T Th
Class Times: 12:30-1:45PM
Mode: Lecture, face-to-face
Class Location: HH 214

Instructor: Professor Uduak George
Email: ugeorge@sdsu.edu
Office Hours: Th 10:00AM-11:00PM, or by appt.
Office Hours Location: GMCS 509

ADDITIONAL COURSE INFORMATION

I'll try to respond to emails within 2 working days, my email is ugeorge@sdsu.edu. For quick questions, the turnaround time may be much shorter. For questions that involve, say, the clarification of course concept, you may want to meet during office hours (see above for days and time for office hours).

Lectures, Homework and Grades will be posted on Canvas

COURSE OVERVIEW

- **Course Description**
  Numerical optimization, Newton, Truncated-Newton, and Quasi-Newton methods for unconstrained optimization; with applications to nonlinear least squares, orthogonal distance regression, and nonlinear equations.
- **Student Learning Outcomes**
  a. Students will be able to identify objective, variables, and constraints for a given problem.
  b. Students will be able to apply optimization algorithms and create computer programs to solve optimization problems.
  c. Students will be able to determine if an optimization algorithm applied to a model has succeeded in its task of finding a solution.
  d. Students will be able to understand the theoretical properties of optimization methods including convergence of the methods.
  e. Students will learn the importance of optimization in artificial intelligence and machine learning.
  f. Students can recognize and give examples of contributions to numerical optimization that have been made by members of diverse cultural and gender groups and other historically marginalized people.

ENROLLMENT INFORMATION

Prerequisites: MATH340 and MATH524 with grades of C (2.0) or better in each course

COURSE MATERIAL

REQUIRED TEXTS:

- *Numerical Optimization*, 2nd Edition, Jorge Nocedal and Stephen J. Wright, Springer Series in Operations Research, Springer Verlag, 2006. ISBN-10: 0387303030; ISBN-13: 978-0387303031
- Class notes

Optional Text:

- *Numerical Methods for Unconstrained Optimization and Nonlinear Equations*, J. E. Dennis, Jr. and Robert B. Schnabel, Classics in Applied Mathematics 16, Society for Industrial and Applied Mathematics (SIAM), 1996. ISBN 0-89871-364-1.
- *Introduction to Linear Algebra*, 5th Edition, Gilbert Strang, Wellesley-Cambridge Press / Society for Industrial and Applied Mathematics, 2016. ISBN-10 0-980-23277-5, ISBN-13 978-0-980-23277-6.

Course Assessment and Grading

- Homework Policy: Homework and project should be submitted via Canvas. Any homework that is more that 5 days late but not more than 7 days late will be worth 80%. Any homework that is more than 7 days late will not be graded unless you make arrangement with me in advance.
- Your final score will consist of homework (65%), project presentation (10%) and project report (25%).
- The following grading scale will be used:

A 93% - 100%	A- 90% - 92.9%			
B+ 87% - 89.9%	B 83% - 86.9%	B- 80% - 82.9%		
C+ 76% - 79.9%	C 72% - 75.9%	C- 68% - 71.9%		
D+ 64% - 67.9%	D 60% -63.9%	D- 55% - 59.9%	F Below 55%	

Tentative Course Schedule

Week		Topics	Readings	
1	Aug 26– 30	Course overview, Syllabus; Introduction to Unconstrained Optimization; Taylor's Formula in Several Variables	Chap. 1	
2	Sep 2 – 6	Convergence; Line Search Methods **Monday, Sep 2: Holiday-Labor Day. Campus closed.**	2-1-2.2	
3	Sep 9 – 13	Line search algorithms; Rate of Convergence; Step Length Selection **09/09 (11:59pm deadline) - Last day for students to add, drop, or change grading basis**	3.1-3.3, 3.5	HW 1 assigned
4	Sep 16 – 20	Eigenvalues and positive definiteness; Trust Region: Cauchy Point and Dogleg; 2-D Subspace Minimization; Nearly Exact Subproblems	4.1-4.5	**HW1 due 09/16**
5	Sep 23 – 27	Global Convergence, and Enhancements; Linear Conjugate Gradient (Part 1)	5.1	HW2 assigned
6	Sep 30 – Oct 4	Linear Conjugate Gradient (Part 2); Nonlinear Conjugate Gradient	5.2	**HW2 due 09/30**
7	Oct 7– 11	Inexact Newton Steps; Line Search Newton Methods; Hessian Modifications	3.4	Project assigned
8	Oct 14 – 17	Trust Region Newton; Derivatives: Finite Differencing	8.1-8.2	HW3 assigned
9	Oct 21 – 25	Automatic Differentiation; Quasi-Newton: The BFGS Method Applications of Optimization by Guest Lecturer on 10/24	6.1-6.2	**HW3 due 10/21**
10	Oct 28 – Nov 1	Symmetric-Rank-1, SR1 Method; The Broyden Class; Quasi-Newton: Convergence Analysis	6.3-6.4	
11	Nov 4 – 8	HW Review; Introduction to Nonlinear Least Squares.	10.1-10.2	HW4 assigned
12	Nov 11 – 15	Nonlinear Least Squares: Algorithms, Large Scale Unconstrained Optimization **Thursday, Nov 11: Holiday-Veterans Day. Campus closed.**	10.3-10.4	**HW4 due 11/11**
13	Nov 18 – 22	Nonlinear Equations; Introduction to Artificial Neural Network	11.1-11.2	HW5 assigned
14	Nov 25 – 29	Numerical Optimization and STEM Diversity **Wed. Nov 27: No classes**	11.3	No classes on 11/27 - 11/29

		Thu. Nov 28 – Fri. Nov 29: Holiday- Thanksgiving recess		
15	Dec 2 – 6	Overview of Constrained Optimization. Project Presentations (Attendance is Mandatory) **Choose a presentation dates (see Canvas for a link with available dates)**	11.3	**HW5 due 12/02**
16	Dec 10	Last day of classes for MATH 693A.		
	Dec 31	Last day of Fall semester. Grades due from instructors at 11pm.		

CLASSROOM CONDUCT STANDARDS

SDSU students are expected to abide by the terms of the Student Conduct Code in classrooms and other instructional settings. Prohibited conduct includes:

- Willful, material and substantial disruption or obstruction of a University-related activity, or any on-campus activity.
- Participating in an activity that substantially and materially disrupts the normal operations of the University or infringes on the rights of members of the University community.
- Unauthorized recording or dissemination of virtual course instruction or materials by students, especially with the intent to disrupt normal university operations or facilitate academic dishonesty. This includes posting of exam problems or questions to on-line platforms.
- Conduct that threatens or endangers the health or safety of any person within or related to the University community, including
    1. physical abuse, threats, intimidation, or harassment.
    2. sexual misconduct.

Violation of these standards will result in referral to appropriate campus authorities.

ACADEMIC HONESTY

The University adheres to a strict policy prohibiting cheating and plagiarism. Examples of academic dishonesty include but are not limited to:

- copying, in part or in whole, from another's test or other examination;
- obtaining copies of a test, an examination, or other course material without the permission of the instructor;
- collaborating with another or others in work to be presented without the permission of the instructor;
- falsifying records, laboratory work, or other course data;
- submitting work previously presented in another course, if contrary to the rules of the course;
- altering or interfering with grading procedures;
- assisting another student in any of the above;
- using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work);
- copying and pasting work from an online or offline source directly and calling it your own;
- using information you find from an online or offline source without giving the author credit;
- replacing words or phrases from another source and inserting your own words or phrases.

The California State University system requires instructors to report all instances of academic misconduct to the Center for Student Rights and Responsibilities. Academic dishonesty will result in disciplinary review by the University and may lead to probation, suspension, or expulsion. Instructors may also, at their discretion, penalize student grades on any assignment or assessment discovered to have been produced in an academically dishonest manner.

Students should not use generative AI applications in this course except as approved by the instructor. Any use of generative AI outside of instructor-approved guidelines constitutes misuse. Misuse of generative AI is a violation of the course policy on academic honesty and will be reported to the Center for Student Rights and Responsibilities.

Essential Student Information

For essential information about student academic success, please see the SDSU Student Academic Success Handbook.

- SDSU provides disability-related accommodations via Student Disability Services (sds@sdsu.edu |https://sds.sdsu.edu/). Please allow 10-14 business days for this process. If you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. You can also learn more about the services provided by visiting the Student Disability Services website. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and I cannot provide accommodations based upon disability until I have received an accommodation letter from Student Disability Services.

Student Privacy and Intellectual Property

The Family Educational Rights and Privacy Act (FERPA) mandates the protection of student information, including contact information, grades, and graded assignments. I will not post grades or leave graded assignments in public places. Students will be notified at the time of an assignment if copies of student work will be retained beyond the end of the semester or used as examples for future students or the wider public. Students maintain intellectual property rights to work products they create as part of this course unless they are formally notified otherwise.

Religious Observances

According to the University Policy File, students should notify the instructors of affected courses of planned absences for religious observances by the end of the second week of classes.

Medical-related absences

Medical-related absences: Students are instructed to contact their professor/instructor/coach in the event they need to miss class, etc. due to an illness, injury or emergency. All decisions about the impact of an absence, as well as any arrangements for making up work, rest with the instructors. Student Health Services (SHS) does not provide medical excuses for short-term absences due to illness or injury. When a medical-related absence persists beyond five days, SHS will work with students to provide appropriate documentation. When a student is hospitalized or has a serious, ongoing illness or injury, SHS will, at the student's request and with the student's consent, communicate with the student's instructors via the Vice President for Student Affairs and may communicate with the student's Assistant Dean and/or the Student Ability Success Center.

Turnitin

Students agree that by taking this course all required papers may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. You may submit your papers in such a way that no identifying information about you is included. Another option is that you may request, in writing, that your papers not be submitted to www.turnitin.com. However, if you choose this option you will be required to provide documentation to substantiate that the papers are your original work and do not include any plagiarized material.

Copyright Policy

SDSU respects the intellectual property of others and we ask our faculty & students to do the same. It is best to assume that any material (e.g., graphic, html coding, text, video, or sound) on the Web is copyrighted unless specific permission is given to copy it under a Creative Commons License. More information about the use of copy written material in education as part of the TEACH Act and Copyright Fair Use Guidelines. Whenever possible, you should attribute the original author of any work used under these provisions.

SDSU Economic Crisis Response Team

SDSU Economic Crisis Response Team: If you or a friend are experiencing food or housing insecurity, or any unforeseen financial crisis, visit http://sdsu.edu/ecrt, or walk-in to Well-being & Health Promotion on the 3rd floor of Calpulli Center.

Resources for students

Counseling and Psychological Services (619-594-5220) offers confidential counseling services by licensed therapists; you can call San Diego Access and Crisis 24-hour Hotline at (888) 724-7240.

Land Acknowledgement

For millennia, the Kumeyaay people have been a part of this land. This land has nourished, healed, protected and embraced them for many generations in a relationship of balance and harmony. As members of the San Diego State University community, we acknowledge this legacy. We promote this balance and harmony. We find inspiration from this land, the land of the Kumeyaay.

Diversity And Inclusion

We are diverse in many ways and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. It is my intent to present course materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Please let me know ways to improve the effectiveness of the course for you personally or for other students. Class rosters are provided to the instructor with the student's legal name. Please let me know if you would prefer an alternate name and/or gender pronoun.