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# MATH 693A ADVANCED NUMERICAL METHODS: COMPUTATIONAL OPTIMIZATION

FALL 2020

Schedule Number: 22403

## COURSE INFORMATION

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**Class Days:** MW

**Class Times:** 12:30-13:45

**Class Location:** zoom.us\* (Live online classes)

**Mode of Delivery:** Live lectures and lecture videos

**Instructor:** Professor Uduak George

**Email:** [ugeorge@sdsu.edu](mailto:ugeorge@sdsu.edu)

**Office Hours:** MW 16:15-17:15 or by appt.

**Office Hours Location:** Zoom.us\*

\* Zoom link to join live lectures and office hours:

<https://SDSU.zoom.us/j/95531701255?pwd=N2UybmRIOXpsN1RDUkpTc1JtQjZGZz09>

Meeting ID: 955 3170 1255

Passcode: 4321

## ADDITIONAL COURSE INFORMATION

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I'll try to respond to emails within 2 working days, my email is [ugeorge@sdsu.edu](mailto: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*

We will be using the Top Hat ([www.tophat.com](http://www.tophat.com)) classroom response system in class. You will be able to submit answers to in-class questions using Apple or Android smartphones and tablets, or laptops.

You can visit the Top Hat Overview (<<https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide>> <https://success.tophat.com/s/article/Student-Top-Hat-Overview-and-Getting-Started-Guide>) within the Top Hat Success Center which outlines how you will register for a Top Hat account, as well as providing a brief overview to get you up and running on the system.

An email invitation will be sent to you by email, but if don't receive this email, you can register by simply visiting our course website: <https://app.tophat.com/e/533536>

*Note: our Course Join Code is: 533536*

Top Hat may require a paid subscription, and a full breakdown of all subscription options available can be found here: [www.tophat.com/pricing](http://www.tophat.com/pricing).

## COURSE OVERVIEW

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- **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.

## ENROLLMENT INFORMATION

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

## COURSE MATERIAL

REQUIRED TEXTS: NUMERICAL OPTIMIZATION, 2<sup>ND</sup> EDITION, JORGE NOCEDAL AND STEPHEN

- *Numerical Optimization*, 2<sup>nd</sup> 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.

## 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 (20%). In-class quizzes/participation is worth 5%.
- The following grading scale will be used:
 

|              |              |              |
|--------------|--------------|--------------|
| A 94% - 100% | A- 90% - 94% |              |
| B+ 88% - 90% | B 84% - 88%  | B- 80% - 84% |
| C+ 78% - 80% | C 74% - 78%  | C- 70% - 74% |
| D+ 68% - 70% | D 64% - 68%  | D- 60% - 64% |
|              |              | F Below 60%  |

## TENTATIVE COURSE SCHEDULE

| Week |                | Topics                                                                                                                    | Readings     |                                         |
|------|----------------|---------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|
| 1    | Aug 24 – 28    | Course overview, Syllabus; Introduction to Unconstrained Optimization                                                     | Chap. 1      |                                         |
| 2    | Aug 31 – Sep 4 | Convergence; Line Search Methods<br>09/04 (7:59pm deadline) - Last day for students to add, drop, or change grading basis | 2-1-2.2      | HW1 assigned                            |
| 3    | Sep 7 – 11     | Line search algorithms; Rate of Convergence; Step Length Selection<br>09/07 – Labor Day holiday, no classes.              | 3.1-3.3, 3.5 | HW2 assigned                            |
| 4    | Sep 14 – 18    | Trust Region: Cauchy Point and Dogleg; 2-D Subspace Minimization; Nearly Exact Subproblems                                | 4.1-4.5      | HW3 assigned<br><b>HW1 due 09/18</b>    |
| 5    | Sep 21 – 25    | Global Convergence, and Enhancements; Linear Conjugate Gradient (Part 1)                                                  | 5.1          |                                         |
| 6    | Sep 28 – Oct 2 | Linear Conjugate Gradient (Part 2); Nonlinear Conjugate Gradient                                                          | 5.2          | Project assigned<br><b>HW2 due 10/2</b> |

|    |                |                                                                                                                                                                                   |           |                                           |
|----|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------------------------------|
| 7  | Oct 5 – 9      | Inexact Newton Steps; Line Search Newton Methods; Hessian Modifications                                                                                                           | 3.4       | HW4 assigned                              |
| 8  | Oct 12 – 16    | Trust Region Newton; Derivatives: Finite Differencing                                                                                                                             | 8.1-8.2   | <b>HW3 due 10/16</b>                      |
| 9  | Oct 19 – 23    | Automatic Differentiation; Quasi-Newton: The BFGS Method                                                                                                                          | 6.1-6.2   | HW5 assigned                              |
| 10 | Oct 26 – 30    | Symmetric-Rank-1, SR1 Method; The Broyden Class; Quasi-Newton: Convergence Analysis                                                                                               | 6.3-6.4   | <b>HW4 due 10/30</b>                      |
| 11 | Nov 2 – 6      | HW Review; Introduction to Nonlinear Least Squares;                                                                                                                               | 10.1-10.2 |                                           |
| 12 | Nov 9 – 13     | Nonlinear Least Squares: Algorithms<br>11/11- Veterans Day                                                                                                                        | 10.3-10.4 | <b>HW5 due 10/12</b>                      |
| 13 | Nov 16 – 20    | Orthogonal Distance Regression; Nonlinear Equations                                                                                                                               | 11.1-11.2 |                                           |
| 14 | Nov 23 – 27    | Practical Methods<br>11/25 - 11/27 – Thanksgiving recess, no classes                                                                                                              | 11.3      | No classes on 11/25 (Thanksgiving recess) |
| 15 | Nov 30 - Dec 4 | Continuation / Homotopy Methods; Overview of Constrained Optimization;<br>Project Presentations (Attendance is Mandatory)<br><a href="#">Link to choose presentation day/time</a> | 11.3      |                                           |
| 16 | Dec 7 -Dec 10  | Project Presentations (Attendance is Mandatory)<br>12/09-Last day of classes for MATH 340                                                                                         |           |                                           |
|    | Dec 31         | Last day of Fall semester. Grades due from instructors.                                                                                                                           |           |                                           |

## 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 WITH DISABILITIES

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If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Ability Success Center at (619) 594-6473. You can also learn more about the services provided by visiting the [Student Ability Success Center](#) website. To avoid any delay in the receipt of your accommodations, you should contact Student Ability Success Center 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 Ability Success Center.

## STUDENT PRIVACY AND INTELLECTUAL PROPERTY

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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

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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

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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

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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

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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

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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>, email [ecrt@sdsu.edu](mailto:ecrt@sdsu.edu), or walk-in to Well-being & Health Promotion on the 3rd floor of Calpulli Center.

## RESOURCES FOR STUDENTS

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A complete list of all academic support services--including the [Writing Center](#) and [Math Learning Center](#)--is available on the Student Affairs' [Academic Success](#) website. [Counseling and Psychological Services](#) (619-594-5220) offers confidential counseling services by licensed therapists; you can Live Chat with a counselor at [http://go.sdsu.edu/student\\_affairs/cps/therapist-consultation.aspx](http://go.sdsu.edu/student_affairs/cps/therapist-consultation.aspx) between 4:00pm and 10:00pm, or call San Diego Access and Crisis 24-hour Hotline at (888) 724-7240.