

Com S 477/577 Syllabus (Fall 2020)

Course Information

- Instructor: **Yan-Bin Jia**
Department of Computer Science
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- Teaching assistant: **Yuechuan Xue**
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- **Lectures:** Tuesday & Thursday 2:10-3:25pm, Curtiss 0105

Couse Format

All lectures will be delivered in the classroom. Homeworks and exams will be given out, turned in, and graded online.

Canvas & Web Page

We will combine the uses of [Canvas](#) and a conventional webpage for this course. Check out Canvas for:

- announcements related to the course;
- clarifications and answers to questions about homeworks in Discussions;
- assignments (**online submissions only**);
- sample solutions to assignments and exams;
- grades.

You are suggested to login to Canvas on a regular basis for announcements regarding homeworks, exams, and other information.

The class also has a conventional web page located at <http://www.cs.iastate.edu/~cs577/>. Here you will find some important materials:

- **lecture notes** (aka the "text" for the course);
- course syllabus & schedule (also on Canvas);
- semester and weekly schedules (also on Canvas).

Prerequisites

(i) Com S 228, (ii) Com S 330 or Cpr E 310, (iii) Math 166 and 207 (or 317); or consent from the instructor

Course Goals and Objectives

This course covers selected topics in algorithms, applied mathematics, and geometry that have found applications in areas such as geometric modeling, graphics, robotics, vision, human machine interface, speech recognition, computer animation, etc. The need for such a course is manifested by the nature of interdisciplinary work that draws upon techniques and expertise across different fields and by the importance of facilitating technical communications and idea exchanges among computer scientists and engineers.

The course objective is to teach computer science and engineering students problem solving skills. Through the course study the students are expected to become acquainted with a collection of powerful mathematical and computational tools, and moreover, to achieve certain understanding of their applications in the real world. In addition, the course strives to keep a sound balance between programming and analytical problem solving.

Computer science students are traditionally trained in discrete mathematics and algorithms but tend to shy away from continuous methods which are increasingly present in the aforementioned applied areas. Meanwhile, engineering students are familiar with continuous methods but often short of necessary background in algorithm design for computer simulation of control and mechanical systems. The introduction of this course expects to address both issues and prepare students for applied research and/or practice.

The course is intended for graduate students and undergraduate seniors in Computer Science, HCI, Mathematics, Electrical and Computer Engineering, Mechanical Engineering, Agricultural Engineering, Aerospace Engineering, and other related engineering fields.

Textbook

No textbook is required. Instruction will be based on [lecture notes](#).

Topics

The following topics will be covered in the course:

1. Projective Geometry
 - homogeneous coordinates
 - lines in the space
 - plane & space transformations
 - perspective projection
2. Rotations in Space
 - rotation matrix
 - Euler angles
 - quaternions
3. Root Finding and Computational Algebra
 - linear equations
 - singular value decomposition
 - nonlinear equations
 - polynomials (evaluation & multiplication)
 - roots of polynomials
 - common roots of multiple polynomials
4. Differential Geometry
 - parametric curves
 - curvature and torsion (Frenet formulas)
 - algebraic curves
 - surfaces
 - surface curves (Darboux frame)
 - normal & principal curvatures
 - Gaussian and mean curvatures
 - geodesics
5. Approximation
 - data fitting (least squares)
 - trigonometric polynomials (Fourier transform)
6. Optimization
 - linear programming
 - simplex method
 - nonlinear optimization
 - Lagrange multipliers
 - calculus of variations

Evaluation

A certain level of self-study is required. You are expected to pursue ideas and topics discussed in this course on your own beyond the lectures.

Regular assignments will be handed out to the students. These assignments entail solving some problems on paper or implementing some of the algorithms discussed in the course.

For graduate credit, you need to complete an essay on some additional topic assigned by the instructor or self-chosen with the instructor's approval. The essay should either address some issue (such as the robustness of a numerical algorithm) that complements a lecture topic, or branch out to an advanced topic (such as matrix

inverse computation) not covered in the lectures. The essay will require 20 to 30 hours of self-study and writing, and make up 10% of the total graduate grade.

Grades will be on the following scales:

	Homeworks	Midterm	Final	Essay
Undergrad	40%	24%	36%	
Grad	36%	21.6%	32.4%	10%

Your final grade will be decided by the following tentative **grading scale** subject to minor adjustments:

at least 85	A
at least 80 but less than 85	A-
at least 75 but less than 80	B+
at least 70 but less than 75	B
at least 65 but less than 70	B-
at least 60 but less than 65	C+
at least 55 but less than 60	C
at least 50 but less than 55	C-
at least 47 but less than 50	D+
at least 43 but less than 47	D
at least 40 but less than 43	D-
less than 40	F

Assignments

All assignments will be posted on Canvas, and typically due on in 7, 12, or 14 days. (Most assignments will take a week.) No homework will be due in the first week, the last week, or the midterm exam week. Typically, there are 11 or fewer assignments.

Homeworks must be submitted **on Canvas before the lecture on the due date**. Any homework turned in after this time will be considered late. Late homework will be accepted until 5pm on the due date for a penalty of 30%. **No homework will be accepted after 5pm.**

Exams

There will be a midterm exam on Tuesday October 6 and a final exam to be determined. To reduce the chance of virus spreading due to indirect contact, both exams will be **online**. To cope with varying home internet speeds, the exams will be each allocated some **extra time no less than the normal time** if taken on campus. For example, a 75-minute midterm exam in class would be given 150 or more minutes online with no change of the difficulty level.

Office Hours

Listed under the front page and the Schedule page, or by appointment. You can ask any questions that you may have regarding lecture material, exams or homework.

All office hours will be held **online via Webex**. The links are as below:

Yan-Bin: <https://iastate.webex.com/meet/jia>

Yuechuan: <https://iastate.webex.com/meet/yuechuan>

General Contact Instructions

If you have a general question about the course or about an assignment, the best place to start is on one of the Canvas discussion topics, where it will be seen by the instructor, the TA, and the rest of the class. However, please do not post personal information, or your solution to an assignment, on Canvas. If a quick response is preferred, you may consider e-mailing the instructor (jia@iastate.edu) or the TA (yuechuan@iastate.edu).

Reference Books

1. D. Marsh. *Applied Geometry for Computer Graphics and CAD*. Springer-Verlag, 1999.
2. A. Pressley. *Elementary Differential Geometry*. Springer-Verlag, 2001.
3. B. O'Neill. *Elementary Differential Geometry*. Academic Press, Inc., 2nd edition, 1997.
4. D. Simon *Optimal State Estimation*. John Wiley & Sons, 2006.
5. J. B. Kuipers. *Quaternions and Rotation Sequences*. Princeton University Press, 1999.
6. I. M. Gelfand and S. V. Fomin. *Calculus of Variations*. Dover Publications, Inc., 2000.
7. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery. [Numerical Recipes in C++: The Art of Scientific Computing](#), 2nd edition, Cambridge University Press, 2002.
8. S. D. Conte and C. de Boor. *Elementary Numerical Analysis: An Algorithmic Approach*. McGraw-Hill, 3rd edition, 1980.
9. D. G. Luenberger. *Introduction to Linear and Nonlinear Programming*. Addison-Wesley, 1984.
10. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein. *Introduction to Algorithms*. The MIT Press and McGraw-Hill, 2nd edition, 2001.
11. G. Strang. *Introduction to Applied Mathematics*. Wellesley-Cambridge Press, 1986.
12. V. Chvátal. *Linear Programming*. W. H. Freeman and Company, 1983.
13. G. H. Golub and C. F. Van Loan. *Matrix Computations*. Johns Hopkins University Press, 1983.
14. J. Gallier. *Geometric Methods and Applications for Computer Science and Engineering*. Springer-Verlag, 2001.

Academic Honesty

The class will follow Iowa State University's policy on academic dishonesty. Anyone suspected of academic dishonesty will be reported to the [Dean of Students Office](#) under the guidance of [Student Disciplinary Regulations](#). If found responsible for the alleged violations, a disciplinary sanction will be imposed as described in [Academic Misconduct](#).

In this course, you may discuss assignments with other students. (Do not assume this is true in all your courses!) We expect you to think through and fully understand assignment solutions. Thus, the solutions you turn in must be written based on your own understanding. Plagiarism will be dealt with harshly. You should consult the University Policy for details regarding academic misconduct and its consequences.

Accessibility Statement

Iowa State University is committed to assuring that all educational activities are free from discrimination and harassment based on disability status. Students requesting accommodations for a documented disability are required to work directly with staff in Student Accessibility Services (SAS) to establish eligibility and learn about related processes before accommodations will be identified. After eligibility is established, SAS staff will create and issue a Notification Letter for each course listing approved reasonable accommodations. This document will be made available to the student and instructor either electronically or in hard-copy every semester. Students and instructors are encouraged to review contents of the Notification Letters as early in the semester as possible to identify a specific, timely plan to deliver/receive the indicated accommodations. Reasonable accommodations are not retroactive in nature and are not intended to be an unfair advantage. Additional information or assistance is available online at www.sas.dso.iastate.edu, by contacting SAS staff by email at accessibility@iastate.edu, or by calling 515-294-7220. Student Accessibility Services is a unit in the Dean of Students Office located at 1076 Student Services Building.

Disabilities for Special Accommodations

Iowa State University complies with the Americans with Disabilities Act and Section 504 of the Rehabilitation Act. Any student who may require an accommodation under such provisions should contact the instructor as soon as possible and no later than the end of the first week of class or as soon as you become aware. Please obtain a SAAR (Student Academic Accommodation Request) form verifying your disability and specifying the accommodation you will need. No retrospective accommodations will be required in this class.

COVID-19 Health and Safety Requirements

Students are responsible for abiding by the university's [COVID-19 health and safety expectations](#). All students attending this class in-person are required to follow university [policy](#) regarding health, safety, and face coverings::

- wear a cloth face covering in all university classrooms, laboratories, studios, and other in-person instructional settings and learning spaces. Cloth face coverings are additionally required to be worn indoors in all university buildings, and outdoors when other people are or may be present where physical distancing of at least 6 feet from others is not possible. Students with a documented health or medical condition that prevents them from wearing a cloth face covering should consult with [Student Accessibility Services](#) in the Dean of Students Office.
- ensure that the cloth face covering completely covers the nose and mouth and fits snugly against the side of the face.
- practice physical distancing to the extent possible.
- assist in maintaining a clean and sanitary environment.
- not attend class if you are sick or experiencing symptoms of COVID-19.
- not attend class if you have been told to self-isolate or quarantine by a health official.
- follow the instructor's guidance with respect to these requirements. Failure to comply constitutes disruptive classroom conduct. Faculty and teaching assistants have the authority to deny a non-compliant student entry into a classroom, laboratory, studio, conference room, office, or other learning space.

These requirements extend outside of scheduled class time, including coursework in laboratories, studios, and other learning spaces, and to field trips. These requirements may be revised by the university at any time during the semester.

In accordance with university policy, instructors may use a face shield while they are teaching as long as they are able to maintain 8 feet of physical distance between themselves and students during the entire instructional period. Some form of face covering must be worn at all times in learning spaces regardless of the amount of physical distancing.

Faculty may refer matters of non-compliance to the Dean of Students Office for disciplinary action, which can include restrictions on access to, or use of, university facilities; removal from university housing; required transition to remote-only instruction; involuntary disenrollment from one or more in-person courses; and other such measures as necessary to promote the health and safety of campus.

It is important for students to recognize their responsibility in promoting the health and safety of the Iowa State University community, through actions both on- and off-campus. The university's faculty asks that you personally demonstrate a commitment to our [Cyclones Care campaign](#). Iowa State University's faculty support the Cyclones Care campaign and ask you personally to demonstrate a commitment to our campaign. Your dedication and contribution to the campaign will also protect your family, classmates, and friends, as well as their friends and families. Our best opportunity for a successful fall semester with in-person learning and extramural activities requires all of us to collaborate and fully participate in the Cyclones Care campaign.

Prep Week

This class follows the Iowa State University Prep Week policy as noted in section 10.6.4 of the [Faculty Handbook](#).

Discrimination and Harassment

Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. Veteran. Inquiries regarding non-discrimination policies may be directed to Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, Tel. 515-294-7612, Hotline 515-294-1222, email eooffice@iastate.edu.

Religious Accommodation

Iowa State University welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request the reasonable accommodation for religious practices. In all cases, you must put your request in writing. The instructor will review the situation in an effort to provide a reasonable accommodation when possible to do so

without fundamentally altering a course. For students, you should first discuss the conflict and your requested accommodation with your professor at the earliest possible time. You or your instructor may also seek assistance from the [Dean of Students Office](#) at 515-294-1020 or the [Office of Equal Opportunity](#) at 515-294-7612.

Statement on Free Expression

Iowa State University supports and upholds the First Amendment protection of [freedom of speech](#) and the principle of [academic freedom](#) in order to foster a learning environment where open inquiry and the vigorous debate of a diversity of ideas are encouraged. Students will not be penalized for the content or viewpoints of their speech as long as student expression in a class context is germane to the subject matter of the class and conveyed in an appropriate manner.

Contact Information for Academic Issues

If you are experiencing, or have experienced, a problem with any of the above issues, email academicissues@iastate.edu.

(Important note to faculty: The email address for contact information is monitored and answered through the Office of the Senior Vice President and Provost)

Emergency Awareness

- For an immediate emergency, call [ISU Police](#) at 515-294-4428.
- During a campus emergency, go to www.iastate.edu for additional information.
- Classroom management emergencies
 - For immediate health/safety concerns, call ISU Police at 515-294-4428.
 - For other concerns regarding classroom management, contact the instructor and/or the chair of the academic department for guidance.
- Know the following information posted in your building [Emergency Map](#).
 - Locate the evacuation routes.
 - Locate the severe weather shelter areas (on the emergency map).
- Keep your contact information up-to-date in the [ISU Alert](#).
- Additional emergency information is available at www.ehs.iastate.edu/prep/students.
- ISU PD Facebook (www.facebook.com/ISUPD) and [Twitter](#).
- To be better prepared during an act of violence on campus and understand the principles of A-D-D (Avoid Deny Defend), please attend [Violent Incident Response Training \(VIRT\)](#).