USC Viterbi
School of Engineering

CSCI 420: Computer Graphics

Units: 4.0
Fall 2024 – 1hr 50 mins, Monday & Wednesday

Location: THH 210

Course Website: https://odedstein.com/teaching/hs-2024-csci-420/

Instructor: Oded Stein
Office: SAL 344

Office Hours: 1h per week with the instructor, 2h with the TAs

Catalogue Description

Computer graphics, OpenGL, 2D and 3D transformations, Bzier splines, computer animation, rendering including ray tracing, shading and lighting, artistic rendering, virtual reality, visualization.

Course Description

This course is an introduction to three-dimensional computer graphics. Students will learn both the theory of 3D computer graphics, and how to program it efficiently using OpenGL. The course primarily teaches the "modern" shader-based OpenGL (core profile), but also introduces the "classic" fixed-function OpenGL (compatibility profile). Topics include 2D and 3D transformations, Bézier and B-Spline curves for geometric modeling, interactive 3D graphics programming, computer animation and kinematics, and computer graphics rendering including ray tracing, shading and lighting. There will be an emphasis on the mathematical and geometric aspects of computer graphics. This course is regularly offered every semester (the instructor may vary from offering to offering, as may the content somewhat).

Prerequisites

Junior, senior, MS or PhD student, or explicit permission of instructor
CSCI 104 (Data Structures and Object-Oriented Design)
MATH 225 (Linear Algebra and Differential Equations) or similar
Familiarity with calculus and linear algebra
C/C++ programming skills

Evaluation

Letter grade. Graded assignments, midterm, and final exam

Technological Proficiency and Hardware/Software Required

Students must be proficient in C++. Students must have a computer with a graphics card that can compile and run C++ code with OpenGL.

Reading Material

The following textbooks are strongly recommended (especially the first one), but not absolutely required:

- Edward Angel: Interactive Computer Graphics: A Top-Down Approach Using OpenGL, Sixth edition, Publisher: Addison Wesley, ISBN: 9780321535863
- Dave Shreiner: OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.3, Eighth edition, Publisher: Addison-Wesley Professional, ISBN: 9780321773036

Description of Assignments and How They Will Be Assessed

There will be three programming homework assignments, teaching students OpenGL and how to program 3D computer graphics. Please see the schedule for links to assignments and due dates. All assignments must be done **individually**.

Grading Breakdown

Assessmenl	% of Grade
Assignments (17% each)	51
Midterm exam	19
Final exam	30
TOTAL	100

All assignments must be completed before the final exam to pass the course. Students must take the mid-term and final exams to pass the course. The assignments will have a small amount of extra credit.

Assignment Submission Policy

Assignments are submitted online through Blackboard / Brightspace
Late policy: Programming assignments should be turned in by midnight on the day they are due. A total of three late days may be taken during the semester on programming assignments. For example, you can use one late day on the second assignment, and two on the third assignment. All days are counted, including any weekends and holidays, as follows:
Less than 24 hours late = 1 late day, 24-48 hours late = 2 late days, 48-72 hours late = 3 late days, and so on. The flexibility provided by the late days is intended to get you through the time where all your classes just happen to have assignments due on the same day. Beyond the three late days, there will be a penalty of 10% of the value of the assignment / day. Exceptions will be granted only under most dire circumstances and must be discussed with and approved by the instructor at least one week in advance. Assignment and exam grading may be discussed within three weeks of them being returned to the students.

Forum

There will be a forum on Piazza where students can ask questions.

Academic Integrity

Unless otherwise noted, this course will follow the expectations for academic integrity as stated in the USC Student Handbook. The general USC guidelines on Academic Integrity and Course Content Distribution are provided in the subsequent “Statement on Academic Conduct and Support Systems” section.

All students are expected to maintain the utmost level of academic integrity. Do not copy any parts of any of the assignments from anyone. Do not look at other students' code, papers, assignments or exams. The university policies on academic conduct will be applied rigorously, and the USC Office of Student Judicial Affairs and Community Standards will be notified.

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words, is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards, https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/. Other forms of academic

dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct/.

If students are found responsible for an academic integrity violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an "F" grade on the assignment, exam, and/or in the course.
Please ask the instructor [and/or TA(s)] if you are unsure about what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity http://equity.usc.edu/ or to the Department of Public Safety http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety whole USC community. Another member of the university community -- such as a friend, classmate, advisor, or faculty member -- can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information http://emergency.usc.edu/ will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

You may not record this class without the express permission of the instructor and all other students in the class. Distribution of any notes, recordings, exams, or other materials from a university class or lectures — other than for individual or class group study — is prohibited without the express permission of the instructor.

Use of Generative AI in this Course

Generative AI is not permitted: Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups as described on each assignment. Students may not have another person or entity complete any portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor (or to the TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Supplementary Reading Material

OpenGL Shading Language
Randi J. Rost.

3rd edition, Addison-Wesley Professional, 2009.
ISBN 9780321637635

Real-Time Rendering.
Tomas Akenine-Möller and Eric Haines.
2nd edition, AK Peters, 2002.
ISBN 1-56881-182-9.

Computer Graphics: Principles and Practice.
James D. Foley, Andries van Dam, Steven K. Feiner, and John F. Hughes.
2nd edition in C, Addison-Wesley, 1996.
ISBN 0201848406.

Fundamentals of Computer Graphics.
Peter Shirley, Steve Marschner.
3rd edition, A K Peters, 2009.
ISBN 1568814690.

An Introduction to Ray Tracing.
Andrew S. Glassner, editor, Academic Press, 1989.
ISBN 0-12-286160-4.

Advanced Animation and Rendering Techniques, Theory and Practice.
Alan Watt and Mark Watt, ACM Press and Addison-Wesley, 1992.
ISBN 0-201-54412-1.

Acknowledgements

I wish to thank Prof. Jernej Barbic, who has taught this course in the past and has graciously granted me access to his course materials.
Thank also goes to Prof. Frank Pfenning and Prof. Jessica Hodgins from Carnegie Mellon University for generously providing materials from their computer graphics courses at CMU. This course has also been influenced by computer graphics courses at Cornell, MIT and UC Berkeley.

Course Schedule

	Topics/Daily Activities	Readings (Angel)	Assignments
Aug 26	What is Computer Graphics?	Ch. 1	
Aug 28	Introduction to OpenGL	Ch. 2	
Sep 2	No Class (Labor Day)		
Sep 4	Graphics Pipeline	Ch. 2	
Sep 9	Color and Hidden Surface Removal	Ch. 2	
Sep 11	Transformations	Ch. 3	
Sep 16	Viewing and Projection	Ch. 4	Assignment 1 released
Sep 18	Shaders	Chs. 1&2, App. A	
Sep 23	Shaders	Chs. 1&2, App. A	
Sep 25	Hierarchical Modeling	Ch. 8	
Sep 30	Polygon Meshes, Curves and Surfaces	Ch. 10	
Oct 2	Splines	Ch. 10	
Oct 7	Lighting & Shading	Ch. 5	Assignment 1 due
Oct 9	Catch-up lecture		Assignment 2 out
Oct 14	Texture Mapping	Ch. 7	
Oct 16	Preparing for Midterm		Assignment 2 first milestone due
Oct 21	Midterm exam (in-class)		
Oct 23	Catch-up lecture		
Oct 28	Rasterization	Ch. 6	
Oct 30	Raytracing: Introduction	Ch. 11	
Nov 4	Raytracing: Geometric Queries	Ch. 11	Assignment 2 due
Nov 6	Spatial Data Structures	Ch. 8	Assignment 3 out
Nov 11	Global Illumination	Ch. 11	
Nov 13	Keyframe Animation	Ch. 9	
Nov 18	Image Processing	Chs. 6&7	
Nov 20	Physical Simulation	Ch. 9	

Nov 25 **Nov 27**	Non-photorealistic rendering No Class (Thanksgiving)	Ch. 9	Assignment 3 due
Dec 2 **Dec 4**	Final prep Final (in-class)		

Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity's website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies
USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.