

22C:251 Advanced Computer Graphics (Advanced OpenGL Rendering)

Syllabus for Spring 2008

Class Time: TTH 9:30 am–10:45 am, 218 MacLean Hall.

Class Webpage: <http://www.cs.uiowa.edu/~cwyman/classes/spring08-22C251/>

Instructor: Chris Wyman

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Office: 101J MacLean Hall

Office Phone: (319) 353-2549

Office Hours: TTh 10:45 am–12:15 pm, or by appointment.

Teaching Assistant: Qi Mo

E-mail: qmo@cs.uiowa.edu

Office Hours: *By appointment only!*

Please Note: Qi will mostly be responsible for handling lectures and questions if I am out of town, and perhaps some grading. Technical questions should generally be directed to the instructor.

Prerequisite: Grade of B or better in 22C:151 **OR** instructor approval. I encourage all students to discuss the course with me prior to the start of the semester. Note that course will assume fluent knowledge of linear algebra, at least a working knowledge of basic calculus, and proficiency engineering and debugging programs.

Course Objective:

Graphics APIs such as OpenGL and DirectX have become commonplace throughout the graphics world, and understanding how they work, their limitations, and ways to work around these limitations is important when writing and extending complex applications. While 22C:151 introduces students to a variety of topics in graphics, such as the basics of OpenGL programming, it relies on basic OpenGL functionality that has been superceded in recent generations of hardware and revisions to the OpenGL API.

This course will start with a quick OpenGL review, focusing on a discussion of the full modern pipeline and introducing concepts (e.g., blending, stencil buffers, and performance considerations) ignored in 22C:151. We will then examine a number of problems in the context of this pipeline, asking “why is this difficult with rasterization?” and proposing alternate ways of structring these problems in order to efficiently implement solutions with hardware acceleration.

After dissecting a few easy-to-grasp problems, further topics to investigate in the context of OpenGL rendering will depend on student interest. These topics may include problems such as antialiasing, bump mapping, object selection via mouse, environment mapping, silhouette edge detection, hidden line removal, noise, non-photorealistic rendering, particle systems, medical and/or scientific data visualization, point rendering, ray tracing, reflections, refraction, shadows, and global illumination. Given time constraints, it is highly unlikely we will cover all these topics.

Please note that this course is an excellent springboard for future research topics. Very few of the solutions we will discuss are ideal; many of the discussed techniques have obvious inefficiencies, artifacts, or other limitations.

Course Requirements:

Course grades will be based on five homework assignments and class participation. Students will be expected to participate in class discussions and think about the material, not to simply copy notes from the board. Thus, class attendance and participation is very important. Students who expect to miss more than two weeks of class (four class periods) should make arrangements to discuss the material with the instructor.

Grades will be determined as follows:

- *Class Participation & Timely Webpage Updates* : 20%
- *Homework Assignments*: 80%

Grades will be on a plus/minus system, but only exceptional cases or close calls will receive a plus or minus. Note that I expect results of your assignments to be posted online and linked from your homepage in a timely fashion (i.e., within a week of submission).

As an advanced graduate-level class, I expect to give mostly (or all) A grades. However, this is based upon the expectation that as an advanced elective, you enjoy graphics and desire your assignments to all be (very nearly) fully functional. When you encounter troubles, I expect you will visit me to discuss your problems so I can help you complete the assignment. An incomplete assignment where I did not even know you were having problems will be looked upon very negatively and will be reflected in both your homework and participation scores, whereas an issue we have discussed multiple times that even I cannot figure out will not present a problem.

Textbooks:

- **Required:** *OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 2.1*, Sixth Edition. By Dave Shreiner, Mason Woo, Jackie Neider, and Tom Davis. Addison-Wesley, 2005. ISBN #0321481003
- **Highly Recommended:** *Advanced Graphics Programming Using OpenGL*. By Tom McReynolds and David Blythe. Morgan Kaufmann, 2005. ISBN #1558606599

The first text is required, and it is expected that students will have a copy from their previous coursework. Students without a copy are encouraged to buy the sixth edition, which covers OpenGL version 2.1. Students owning the fifth edition need not invest in the new version, but may need to consult online manuals for updated information.

The second text is highly recommended, and is the result of 5 years of SIGGRAPH course notes from the circa 2001 “Advanced OpenGL” course. As such, it is extremely clear for a book on advanced graphics techniques and includes detailed pseudocode for straightforward implementation. However, while the book provides an excellent reference for advanced techniques using the fixed-function pipeline, the introduction of extraordinary hardware programmability has rendered a number of the discussed techniques obsolete since 2001. However, these methods still serve as perfect examples for use of more exotic fixed-function GPU capabilities that cannot be efficiently duplicated using programmable methods.

Other academic publications, handouts, and other references may be discussed during the semester.

Late Assignments:

Assignments turned in late will incur the following penalties:

- 1 day late: -10%
- 2 days late: -33%
- 3 days late: -75%
- 4+ days late: -100%

However, all assignments *must* be turned in to pass the class. Also note that (unlike 22C:151) there are *no* free late days. As you will have longer to work on assignments, it is expected you will start early enough to cope with unexpected difficulties, computer problems, or life events. Exceptions will be granted very rarely.

Academic Honesty:

As an advanced class, I expect you all to take pride in your own work and not stoop to “borrowing” someone else’s code and passing it off as your own. To allow programming and discussion to occur at a higher level than in 22C:151, however, I plan to provide a number of code snippets than hide the sometimes-messy OpenGL details. The use of other OpenGL-related code is forbidden without prior approval, but you may use other code (e.g., math libraries) provided you document where it was obtained in your README and provide an original copy with your submission.

Unlike most classes, where a large variety of online code examples can help your understanding of a problem even without copying, using such techniques with this class will cause you an inordinate amount of problems: at least as many online “examples” of these OpenGL techniques are wrong as are right, and many of the “right” ones include unstated assumptions that make the code difficult to understand. Other techniques to be discussed have no examples

online, or only those presented in the context of an original scientific paper. I highly encourage you avoid searching online for help, instead of sending me an e-mail or stopping by my office! If necessary, I'll point you to more credible references.

Some assignments this semester will be single-person assignments, and some will likely allow collaboration in a small group (e.g., 2 people). In either case, all code (except as noted above) must either be your own work or – if allowed – the work of you and your teammate.

Should you need clarification on what constitutes academic dishonesty, contact me or consult the printed policy in the *Schedule of Courses*, the *CLAS Bulliten*, or online at:

http://www.clas.uiowa.edu/faculty/teaching/classroom_p&p/acad_fraud_etc.shtml.

Further Considerations:

Given that no exams will be given, no “makeup exams” should be necessary. However in place of a final exam, I plan to have you all demonstrate/present your final homework project to the class. This will be part of your participation grade, and I expect you will attend except under the circumstances allowed under the University of Iowa’s policy on absences from examinations: http://www.clas.uiowa.edu/faculty/teaching/classroom_p&p/general_exam_p&p.shtml

If you expect you may need to miss this, please inform me as far in advance as possible so we can attempt to reschedule the meeting for the entire class.

I need to hear from any student with a disability that requires modification to seating, testing, or other class requirements. Please talk with me as soon as possible during office hours, so that appropriate arrangements can be made in a timely fashion. More information: http://www.clas.uiowa.edu/faculty/teaching/classroom_p&p/disabilities.shtml

Note: As a course offered by the College of Liberal Arts and Sciences, course policies are governed by the CLAS.

Complaints:

If you have complaints, please feel free to discuss them directly with me during office hours or via e-mail. If you have problems with the TA, please attempt to resolve them with her first before contacting me. If you do not feel I have appropriately dealt with your complaint, you should consult the Computer Science DEO/Chair, Professor Jim Cremer, 14D MacLean Hall, (319) 335-1713, cremer@cs.uiowa.edu. If still unresolved, complaints must be submitted in writing to (for undergrads) Helena Dettmer, the CLAS Associate Dean for Academic Programs, or (for grads) to Eric Wurster, Graduate College Associate Dean for Academic Affairs. Further information about this policy is available at: http://www.clas.uiowa.edu/students/academic_handbook/ix.shtml#4.