CS F684 Advanced Computer Graphics Fundamentals

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Office Hours	MW 2:30-3:30 pm, or by appointment
Course Number	CS F684
Credits	3
Prerequisites	CS F202 and MATH F253X
Method	Lecture
Course Website	`https://classes.alaska.edu`
Location	UAF Campus in ELIF 301
Meeting Time	MW 3:30-5:00 pm
Final	Monday, December 9, 3:15-5:15pm
Reading Materials	Realtime Rendering 4th edition by Tomas Akenine-Möller et. al. ISBN: 978-1138627000
Recommended Reading	Ray Tracing in One Weekend by Peter Shirley (`https://github.com/petershirley/raytracinginoneweekend/releases/`)

1. INTRODUCTION

Catalog Description. Creation of computer-generated images using 3D graphics hardware. Mathematics and data structures in 3D graphics. Sprites, Tiles, Typography, and Vector Graphics in 2D graphics. Color, lighting, textures, hidden surface removal. Loading and saving scene graphs; Using physically based and nonphotorealistic shading. Software design principles to create interactive applications.

In this class, we are going to investigate the fundamentals of computer graphics. This is a large field in computer science because it taps into many different disciplines ranging from producing realistic images to augmented and virtual reality to video games and movies. In our class we want to introduce a wide breadth of mathematics and algorithms that may be used in a wide variety of applications.

2. COURSE OUTCOMES

In this section, we cover the list of course topics. This is what you should expect to be able to do when the course is completed.

- Identify common uses of digital presentation to humans
- How to represent analog signals with discrete samples
- Construct a simple user interface using a standard API
- Describe color models and their use in graphics display devices
- Apply 3-dimensional coordinate system to handle transformations in 3D
- Discuss the light transport problem and its relation to numerical integration
- Create and display 3D models of simple graphics images
- Implement a simple real-time renderer using a rasterization API
- Apply graphics and game design to create an interactive 3D experience

3. GRADING OVERVIEW

The course load consists of two exams, several homework assignments, and a research project. The lowest *non-zero* homework grade will be replaced by the average grade of the remaining homework grades (0's included!), so ALL homework must be completed. The exams are primarily based on the content of the assigned readings or videos. This is summarized in the table below.

IMPORTANT! Homework and Project Deliverables are due before midnight. Late homework may get penalized one whole letter grade each day that it is late starting at 12:00am and late homework after 3 days may receive no credit. I encourage students to communicate if they are having difficulties. If Blackboard is down for maintenance, then submit when it comes back online the next day.

3.1. Grading Division

Points	%	Type
2000	20%	Midterm Examination
2000	20%	Final Examination
4000	40%	Homeworks
1500	15%	Research Project
500	5%	Class participation
10000		

3.2. Grading Schema

A+	97-100	**A**	93-96	**A-**	90-92
B+	87-89	**B**	83-86	**B-**	80-82
C+	77-79	**C**	73-76	**C-**	70-72
D+	67-69	**D**	63-66	**D-**	60-62
F	0-59				

3.3. Homework Grades

The homework assignments are graded with the following scheme. Several items are pass/fail for the entire homework assignment. In other words, they must be completed or no credit at all is given regardless of the completion of the other items. Graduate students will be graded according to the following scheme.

IMPORTANT! Pass/Fail items are immediately returned with a 0 score until fixed. Students should therefore check their assignment over before submission.

- (Pass/Fail) GitHub project
- (Pass/Fail) Overleaf Report written in LaTeX
- (Pass/Fail) Report submitted on Blackboard as a PDF (`lastname.firstname-hwN.pdf`)
- (Pass/Fail) Report includes link to GitHub repository
- (500 pts) Deliverables
  - (50 pts) Report contains *design* paragraph (~100 words)
  - (50 pts) Report contains *post mortem* paragraph (~100 words)
  - (50 pts) Report includes answers to assignment questions
  - (50 pts) Report contains *sample run* or *screenshot*
  - (50 pts) Source Code has `Makefile` or Visual Studio Solution `.sln`
  - (50 pts) Source Code is neat and documented
  - (100 pts) Program incorporates an interesting user interaction
  - (50 pts) 3 of the *additional requirements* are completed
- **NOTE**: Some assignments may not include a program assignment and will include specific instructions
- **NOTE**: The assignment instructions may include additional deliverables. Always be aware of what the assignment specifically requires.

3.4. Research Project

The Research Project is a programming project with several phases and an accompanying journal written in LaTeX. The phases include the *Author Bio*, *Pitch*, *Proposal*, *Project Updates*, *State of the Art*, *Results*, *Post Mortem*, and *Presentation*. The theme and specific details will be discussed in class. Graduate students will have additional project requirements in the area of state of the art research and implementation.

3.5. Class Participation

Every week, one graduate student will present the results or method of a research paper in a short presentation (5 minutes or ≈ 500 words). We will go round robin until all students has presented at least two different research papers. Each presentation is worth 250 points of the participation grade.

4. SCHEDULE

Week	Topics	Other[1]
1	Survey of 3D Graphics, Fundamentals	HW 0, RP *Author Bio*
2	3D Mathematics	HW 1
3	Graphics Pipeline, GPUs, Transformations	HW 2, RP *Pitch*
4	Modeling and 3D Representations	HW 3
5	Human Computer Interaction, 2D Games	RP *Proposal*
6	Shading Basics, Texturing, Light & Color	HW 4, RP *Project Update 1*
7	Animation, Scene graphs, Design Patterns	RP *State of the Art*
8	SOTA Presentations & Midterm Review	Midterm
9	Physically Based Shading	HW 5
10	Global Illumination, Image Space Techniques	HW 6, RP *Update 2*
11	Ray Tracing	HW 7
12	Procedural Generation	HW 8, RP *Update 3*
13	Game Design	Thanksgiving break
14	Miscellaneous topics	RP *Results, Post Mortem*
15	Final Presentations and Final Review	RP *Presentation*

5. COURSE POLICIES

Students are expected to be at every class meeting on time, and are responsible for all class content, whether present or not. If absence from class is necessary, students may make up in-class work (other than quizzes) and homework only on the instructor's approval; arrange absences due to scheduled events ahead of time.

Students who fail to attend the first class meeting after registering for the class, or who miss four consecutive class meetings, may be dropped from the class without warning, unless prior arrangements are made with the instructor.

Academic dishonesty will not be tolerated, and will be dealt with according to UAF procedures. You may discuss homework and lab assignments with others, but everything you turn in must be your own work. Students in this class pay the CS lab fee. Payment allows access to open computer labs on the 5th floor of the Duckering building.

- UAF academic policies `http://www.uaf.edu/catalog/current/academics`
- CS Department policies `http://www.cs.uaf.edu/departmental-policies`

[1] HW = homework, RP = research project