CS 216 Physically Based Modeling for Film and Games

Course Information

- Instructor: Kevin M. Smith
  - Email: kevin.smith@sjsu.edu
  - Office Hours:
    - Mondays & Wednesdays 3:30 PM – 4:30 PM
    - Location: DH 282
    - You do NOT need to make an appointment for these office hours. You can simply stop by my office.
- Class Days/Time: 10:30-11:45
- Class Location: Clark 238 Building (Tuesdays), Online (Thursdays)
- CS 116A with a grade of B or better, or its equivalent, or with permission from the instructor.

Catalog Description

This course provides a physically based approach to creating realistic images and animation with applications in both the film and games industry. In a project-based approach, students will study the algorithms commonly used for real-time animation in games and rendering.

Course Summary

This course provides a physically based approach to creating realistic images and animation with applications in both the film and games industry. Simulating reality will be the primary goal by modeling the interaction of light and matter to create photorealistic images. For animation, we will explore the use of rigid and soft-body dynamics to produce realistic animations using physics. In a project-based approach, students will implement the algorithms covered in the course to solve problems found in both the film and game industry. Some of the topics covered: Ray marching fractals and terrain, real-time simulation of particle effects, flocking, simulation of clothing, organic modeling with subdivision surfaces, and AI-driven approaches to animation. A variety of platforms will be used including a C++/OpenGL framework and industry standard applications such as Maya and Houdini.

Course Learning Outcomes (CLO)

Upon successful completion of this course, students will be able to:

- Describe in detail the mathematics and software algorithms required to implement the physically based rendering and animation techniques used in the film and games industry.
- Implement three projects using techniques from physically based rendering and animation. The students will use C++ and an embedded programming language in a 3D modeling package, depending on the project.
- Determine how different use-cases in computer graphic production can be solved using the techniques covered in the course.
- Combine several physically based modeling techniques and a *use case* to create a comprehensive final project prototype and presentation.

Textbooks and Recommended Reading

- Steve Marshner, Peter Shirley, *Fundamentals of Computer Graphics (Fourth edition)*, CRC press, 2016 (Required)
- Matt Pharr, Greg Humpreys, *Physically Based Rendering (Third Edition Online)*
- Piegel, Tiller, *The NURBS Book (Second Edition)*, Springer 2003 (Recommended Reading)

Other Equipment

- OpenFrameworks C++ Development environment available on Windows and Mac (free)
- Houdini (Apprentice Student Edition) (free)
- Maya Educational Version (free)
- Student is required to have a reasonably fast laptop or desktop computer capable of running 3D software and development tools.

Grading

Exams, Assignments, and Projects

- A minimum of four (4) Programming Projects
- A midterm
- Labs (mostly completed in class)
- Final Project (includes prototype and presentation)

Item	% in Final Grade
Programming Projects	50%
Midterm	10%
Labs	10%
Final Project	30%

Grading Table

Total Grade	Letter Grade
97% and above	A plus
93% to 96%	A
90% to 92%	A minus
87% to 89%	B plus
83% to 86%	B
80% to 82%	B minus
77% to 79%	C plus
73% to 76%	C
70% to 72%	C minus

67% to 69%	D plus

Total Grade	Letter Grade
63% to 66%	D
60% to 62%	D minus
59% and below	F

Extra-credit and Reworks

No additional extra credit assignments or rework opportunities will be given.

Late Submission

Late submissions within 24 hours will be deducted 10% of its final grade. Submissions over 24 hours late will have 20% grade deducted. Late submissions over 2 days will not be accepted.

Laptop and Cell Phone Policy

With exception of labs that are completed in class, laptops are only permitted for taking notes for the class. Cell phones are not permitted to be used in class unless required to login into the SJSU system.

Attendance

Class attendance is required to gain maximum benefit from the course material. Students not attending either of the first two classes will be dropped to make room for students on the waiting list. Attempting to get marked as present (by having someone else attend in your place or using technological deceptions) will be considered academic dishonesty and at a minimum will result in you getting dropped from the course.

Course Content Policy

The class materials (including any lecture slides, notes, videos and PDF files) are protected by copyright. It is illegal to copy or distribute the class materials without permission from the instructor. There is no photography allowed (including mobile phone cameras) or recording of the lectures permitted without permission of the instructor.

Grading Policy

The University Policy S16-9, Course Syllabi (http://www.sjsu.edu/senate/docs/S16-9.pdf) requires the following language to be included in the syllabus:

“Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally three hours per unit per week) for instruction, preparation/studying, or course related activities, including but not limited to internships, labs, and clinical practica. Other course structures will have equivalent workload expectations as described in the syllabus.”

Fall 2022 Announcement: COVID-19 and Monkeypox

Students registered for a College of Science (CoS) class with an in-person component should view the CoS COVID-19 and Monkeypox Training slides for updated CoS, SJSU, county, state and federal information and guidelines, and more information can be found on the SJSU Health Advisories website. By working together to follow these safety practices, we can keep our college safer. Failure to follow safety practice(s) outlined in the training, the SJSU Health Advisories

website, or instructions from instructors, TAs or CoS Safety Staff may result in dismissal from CoS buildings, facilities or field sites. Updates will be implemented as changes occur (and posted to the same links).

University Policies

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information web page at http://www.sjsu.edu/gup/syllabusinfo/. Make sure to review these policies and resources.

Tentative Schedule and Topics

Date	Topic	Reference	Note
1/25	Overview		
1/30	Polygon Meshes		
2/1	Polygon Meshes and Intro to OpenFrameworks		
2/6	Case Study – Procedural Modeling in Houdini		
2/8	Subdivision Surfaces		
2/13	Subdivision Surfaces		
2/15	Case Study – Subdiv modeling in Maya		
2/20	Basic Ray Tracing		
2.22	Case Study – PBRT (Physically -Based Rendering)		
2/27	Case Study – PBRT rendering a simple scene		
3/1	Ray Marching and SDF's		
3/6	Ray Marching and SDF's		
3/8	Case Study – Rendering SDF-based geometric Primitives		
3/13	Fractals 2D		
3/15	Fractals 3D		
3/20	Case Study – Creating the Mandelbulb 3D fractal		
3/22	NURBS Curves and Surfaces		

3/27	Spring Recess (no classes)	
3/29	Spring Recess (no classes)	
4/3	NURBS Curves and Surfaces	
4/5	NURBS Curves and Surfaces	
4/10	Delaunay Tessellation and Surface Fitting – Point Clouds	
4/12	Final Project Discussion	Project Topic Due
4/17	Case Study – Reality Capture	
4/19	Case Study – Cloth Simulation	
4/24	Volumetric Modeling	
4/26	Volumetric Modeling	
5/1	Case Study – Modeling Clouds and Natural Phenomena	
5/3	Advanced Topic 1	
5/8	Advanced Topic 2 (or Guest Speaker)	
5/10	Final Presentations	Final Project Content Due
5/15	Final Presentations	