New York University Tandon School of Engineering
Computer Science and Engineering

CS-GY 6533 A – Interactive Computer Graphics

Instruction Mode: Blended (Online & In-Person)

Fall 2020

Course Instructors

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Jonathas Costa

Teaching Assistant

TBA

COVID 19

The instruction mode for this class is **blended**, what means that students can attend the class in person or remotely. Students are encouraged to participate in class synchronously, but all sessions will be recorded.

We will be meeting in 2 Metro Tech Center Rm 9.011. This classroom can normally fit 68 students, and NYU has determined that its **socially distant capacity** is 20 students. If more than 20 students elect to attend the class in-person, the class will need to be assigned into cohorts.

Seat tracking is mandatory, and students will select a seat during the first day of classes.

All office hours will use Zoom. Discord will be the main platform for instructor / student communications.

Acknowledgement

This course is based on the computer graphics course designed by Professor Daniele Panozzo (NYU). We first offered it at Tandon on Fall 2019. In that offering, we used similar assignments, but introduced lectures on shadows, antialiasing, and scientific visualization. For this second offering, we are further modifying the course to address student feedback, and to update the content. We are also making modifications to adapt the content and delivery to the unique situation of the COVID-19 pandemic.

Course Pre-requisites

Graduate standing, CS-GY 5403 (Data Structures) or equivalents and knowledge of C or C++ programming.

Course Description

This course provides an introduction to the field of Computer Graphics. We will cover the basic mathematical concepts, such as 2D and 3D transformations, study the interaction of light with geometry to derive shading models, the representation of geometric data in the memory, and implement iterative rendering algorithms. We will investigate how these fundamental components are integrated into current graphics processors (GPUs) and study the corresponding programming APIs (OpenGL and GLM). This course will also include a brief introduction to C++.

Students will experiment with modern graphics programming and build small demos in C++ and OpenGL.

By the end of the course, the student must be able to:

- Explain and apply the fundamental mathematical concepts used in image synthesis algorithms
- Implement a basic real-time rendering pipeline based on rasterization
- Implement visual effects such as shadows and reflections on rasterization pipelines
- Be able to model scenes using triangulated models
- Develop simple graphics programs in C++ using OpenGL and GLSL

Course Objectives

To study core concepts, algorithms, data structures, and techniques in Computer Graphics. By the end of the course, it is expected that students will be able to design and implement their own graphical applications, as well as have understanding of the theoretical underpinnings of graphics algorithms.

Course Structure

Theory and practical lectures on the subject, course readings, and programming assignments.

We will pre-record parts of the lectures ahead of time. Also, each class will have required reading assignments. We note that we will also have optional reading materials.

We plan to use the class time for fluid interaction with the students, often through Q&A and/or guided exploration sessions.

Readings

Textbook: Fundamentals of Computer Graphics, 4th Edition December 18, 2015 by A K Peters/CRC Press Textbook - 734 Pages - 541 Color ISBN 9781482229394.

Optional and recommended texts are:

- OpenGL Programming Guide 9th Ed. (8th Ed. can also be used), Addison Wesley
- Real Time Rendering 4th Ed., CRC Press

Grading: This class **will not** have any written exams. All the grading will be based on assignments, quizzes, and class participation. **We will check all assignments for plagiarism, and strictly enforce university rules.**

Assignments

- Assignment 1: Images, Morphological Operators (15% of final grade)
- Assignment 2: 2D Vector Graphics Editor (25% of final grade)
- Assignment 3: 3D Scene Editor (30% of final grade)
- Assignment 4: Shadows, Reflections, and Depth Maps (30% of final grade)

Late Submissions

Late submissions of assignments will be penalized as follows:
- A standard deduction rate of 20% per day.

It means that after 5 days of being late, your assignment will have a maximum grade of 0 (zero).

Course Schedule

The course schedule is tentative and will be adjusted along the way.

<u>Part I: Introduction and Ray Tracing</u>

01 - Introduction, Images
Chapters 1, 2 and 3

02 - Ray Tracing, C++
Chapters 4 and 10

03 - Basic Linear Algebra and 2D Transformations
Chapters 2, 5 and 6

<u>Part II: Rasterization and OpenGL</u>

04 - Viewing Transformations and Rasterization
Chapters 7 and 8

05 - The OpenGL Graphics Pipeline
Chapters 8 and 17, https://open.gl/, http://docs.gl/

06 - The OpenGL Graphics Pipeline - Part 2
Chapters 8 and 17, https://open.gl/, http://docs.gl/

07 - Texture Mapping
Chapter 11

08 - Shadows
Chapter 11, OpenGL Red Book Chapter 7

09 - Antialiasing
Chapter 8, OpenGL Red Book Chapter 4 and 8

10 - Spatial Data Structures
Chapter 12

11 - Mesh Data Structures
Chapter 12

12 - Texture Synthesis

<u>Part III: Introduction to Scientific Visualization</u>

13 - Scientific Visualization: Isosurfaces

14 - Scientific Visualization: Volume Rendering

15 – Advanced Topics (TBD)

Moses Center Statement of Disability

If you are a student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities (CSD) at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 3rd floor.

NYU School of Engineering Policies and Procedures on Academic Misconduct

– Complete Student Code of Conduct can be found here.

A.   Introduction: The School of Engineering encourages academic excellence in an environment that promotes honesty, integrity, and fairness, and students at the School of Engineering are expected to exhibit those qualities in their academic work. It is through the process of submitting their own work and receiving honest feedback on that work that students may progress academically. Any act of academic dishonesty is seen as an attack upon the School and will not be tolerated. Furthermore, those who breach the School's rules on academic integrity will be sanctioned under this Policy. Students are responsible for familiarizing themselves with the School's Policy on Academic Misconduct.

B.   Definition: Academic dishonesty may include misrepresentation, deception, dishonesty, or any act of falsification committed by a student to influence a grade or other academic evaluation. Academic dishonesty also includes intentionally damaging the academic work of others or assisting other students in acts of dishonesty. Common examples of academically dishonest behavior include, but are not limited to, the following:

1.   Cheating: intentionally using or attempting to use unauthorized notes, books, electronic media, or electronic communications in an exam; talking with fellow students or looking at another person's work during an exam; submitting work prepared in advance for an in-class examination; having someone take an exam for you or taking an exam for someone else; violating other rules governing the administration of examinations.
2.   Fabrication: including but not limited to, falsifying experimental data and/or citations.
3.   Plagiarism: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise; failure to attribute direct quotations, paraphrases, or borrowed facts or information.
4.   Unauthorized collaboration: working together on work meant to be done individually.

5.   Duplicating work: presenting for grading the same work for more than one project or in more than one class, unless express and prior permission has been received from the course instructor(s) or research adviser involved.

6.   Forgery: altering any academic document, including, but not limited to, academic records, admissions materials, or medical excuses.

NYU School of Engineering Policies and Procedures on Excused Absences

– Complete policy can be found here.

A.   Introduction: An absence can be excused if you have missed no more than 10 days of school. If an illness or special circumstance has caused you to miss more than two weeks of school, please refer to the section labeled Medical Leave of Absence.

B.   Students may request special accommodations for an absence to be excused in the following cases:

1.   Medical reasons
2.   Death in immediate family
3.   Personal qualified emergencies (documentation must be provided)
4.   Religious Expression or Practice

Deanna Rayment, deanna.rayment@nyu.edu, is the Coordinator of Student Advocacy, Compliance and Student Affairs and handles excused absences. She is located in 5 MTC, LC240C and can assist you should it become necessary.

NYU School of Engineering Academic Calendar

 – Official calendar can be found here.

Also, please pay attention to notable dates such as Add/Drop, Withdrawal, etc. For confirmation of dates or further information, please contact Susana: sgarcia@nyu.edu