Syllabus for CS 452 / CS 552 / EE 465 / EE 505 Computer Graphics

Class hours: 1:30 PM to 2:45 PM on Tuesday and Thursday
Instructor: Natasha Banerjee (nbanerje@clarkson.edu, but preferred communication is via Slack)
Instructor Office Hours: Mondays to Fridays, 1pm to 10pm via Slack. **Office hours are virtual only and conducted via Slack.** The time slot 6pm-7pm on T and Th only is available if dedicated time is needed for virtual-face-to-face over Zoom, all other hours are for text-based communication via Slack.

Course TA: Nikolas Lamb (lambne@clarkson.edu, but preferred communication is via Slack)
TA Office Hours: TBA

1. **Course Objectives**
   - *Objective 1:* To learn the theory of computer graphics (geometry of image formation, coordinate transforms, illumination of objects, textures, anti-aliasing).
   - *Objective 2:* To perform practical implementations of the theory by writing computer graphics applications using WebGL.

2. **Course Description**

This course will cover techniques in computer graphics related to image formation, shaders, 2D graphics, animation, 3D graphics including designing 3D shapes, positioning cameras, applying lighting and texturing, and additional techniques such as shadow generation and bump mapping.

3. **Pre-requisites**

   CS142, EE262, or a second level data structures programming course is a pre-requisite. Algebra of matrix multiplication is also a pre-requisite, i.e., MA232 and MA239 are pre-requisites or MA339 is a co-requisite.

Note on the mathematical component of this course
This is a math-intensive course! A well-rounded knowledge of matrix multiplication, general algebra and arithmetic is required to be successful in the assignments, projects, and exams in this course. Students without a strong mathematical foundation through the aforementioned math pre/co-requisites stand to face challenges in following the material, implementing the projects and assignments, and being successful in the exams.

Every year, I have had a student or two complain about the mathematical rigor of this course, which is why I am including this note to discuss why the course is math-intensive. Computer graphics depends upon mathematics to render content. Since this

course is part of the computer science major that focuses on both programming and mathematics, I teach the course with both those focuses as well. I keep the mathematical rigor for another reason too: For a variety of jobs with computer graphics as the focus (e.g., CAD, virtual reality, augmented reality, animation, game design), employers are looking for candidates who can program new algorithms or re-program algorithms for new environments. Given that computer graphics algorithms are supported by math, these jobs require the candidate to be mathematically adept. With a good background in computer graphics math, you will be a strong candidate for these positions.

In particular, students who have taken MA232 and MA239 should be comfortable matrix multiplication. Students who are co-taking MA339 should learn matrix multiplication by around the third week of class (please let me know if you are in MA339, and this is not the case). In graphics, we will start using matrix multiplication by the fourth week of class.

Students seeking a non-mathematical experience to computer graphics are advised to consider taking courses offered in the Digital Arts program.

4. Required Material

None

5. Recommended Textbooks (not Required for the class, but an excellent reference)

Angel & Shreiner, *Interactive Computer Graphics: A Top-Down Approach with WebGL,* Seventh Edition. Note: if you do get this textbook, you should get the seventh edition: you cannot purchase earlier editions, as the earlier editions do not use WebGL.
OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 3.0 and 3.1 (colloquially termed the Red Book)

6. Course Format

The course is in-person, but to remain safe given the pandemic situation, we will be conducting some classes online. I live with an immunocompromised individual, and as such I will require all students to strictly follow CDC, state, and university mandates and guidelines on COVID-19 safety. I will be using Slack to run the class so that we can have a fluid persistent communication within and outside class. I will also be recording all class lectures using Zoom, which I will be initiating through Slack. Students can log into Zoom via the link posted in Slack. However, **access to recordings will only be provided to a student if they are unable to attend class due to exigent circumstances related to sickness, please refer to the Attendance section for details.**

7. Required Technology

The following is required for successful optimal engagement in this course:

- A computer with Windows, macOS, or Linux operating system.
- Slack --- This is the primary communication and collaboration application that will be used in this class. Slack has desktop, web, and mobile interfaces. All students will be invited to the workspace for the course before the start of the first day of class. Students are highly recommended to access the sign-up link, and have Slack setup, particularly for use from their computer.
    - Lecture material, project assignment write-ups, and polls will be posted to Slack.
    - Students will be able to ask questions through the Slack channels. The instructor will provide responses to questions on the channels. Students will also be encouraged to interact, and respond to student questions to promote a collaborative atmosphere.
- A text editor to write JavaScript code, such as Sublime for any OS, Notepad++ for Windows, Xcode/Vim for macOS, Vim/Emacs for Linux.
- Access to Moodle --- Moodle will be used to provide grades for assignments and projects.
    - Note that Moodle is *not* being used in this class as the primary learning management system, i.e., lectures and announcements will not be conducted via Moodle, rather they will be conducted through Slack. Lecture material will also be posted to Slack. Moodle will only be used as a grading tool in order to protect privacy of student grades.

8. Course Policies

8.1. Attendance Policy

Students are required to attend all lectures at the time they are held, i.e., 1:30pm to 2:45pm Tuesday and Thursday. If classes are held online for all students, a Zoom link will be shared for that day's sign-in. Attendance will be taken for all classes, whether in-person or online, and will constitute 10 points of the final grade. The first Thursday and first Tuesday of class will not count, and on top of those 2 days, you can take 2 additional days off at any point in the semester. Skipping the first 2 days and the additional 2 days will still entitle you to 10 points. If you skip any further days, you will lose **all 10 points**, unless you are skipping class because you are sick, in which case I will require a letter from the Dean of Students indicating that you will not be able to attend class.

Distance students will be expected to attend via Zoom at the time of the lecture, unless pre-existing commitments make class-time attendance impossible, in which case students should discuss with the instructor for a different arrangement. The class will be recorded. Zoom links and recordings will be released on Slack only.

As stated earlier, we may need to be prepared to pivot to online mode if the pandemic situation worsens. In this case, all students will be required to attend via Zoom during the class time.

8.2. Etiquette during lecture

When we are in-person, please follow all mandates regarding social distancing and mask wearing. If you have to join via Zoom (either because I am conducting the class over Zoom, or because you are sick and need to remain socially distanced), please have audio turned off to prevent background noise. This semester, please feel free to have your video turned on if you are comfortable doing so. I find that it encourages more interactions amongst students when the video is on. All students can feel free to ask questions during class. Students on Zoom are requested to use the 'raise hand' feature for question-asking.

You can (and in fact you are *recommended* to) use Slack, by posting your question in the channel for that day's lecture. The advantage of this is that your question will persist for everyone to see and be able to refer to later. This persistence is vital for a holistic experience that extends well outside the lecture period. The instructor will be monitoring her view of the lecture channel on the class Slack workspace, and will respond to posted questions. If you wish to keep your question private, post a direct message (DM) to the instructor on Slack. The instructor will be monitoring her DM as well, and will keep DM questions anonymous.

8.3. Recording Disclaimer

All Zoom lectures conducted during the class hours **will be recorded** and shared on Slack for post-class viewing to all students. Specifically, the audio for any questions you ask or responses you provide by unmuting yourself will be recorded.

8.4. Office hours policy

Given the current pandemic situation, and since I live with an immunocompromised individual, I am conducting office hours virtually via Slack. When contacting me for assistance, please DO NOT SIMPLY SAY YOU NEED HELP WITH YOUR CODE WITHOUT SHOWING YOUR CODE FIRST! I will not be able to help you unless you show me your code first. The same applies to Nik, the TA.

Example of proper Slack communication etiquette is as follows:

@Nikolas Lamb <or> @Natasha Banerjee: I am having trouble with writing the vertex shader for Assignment 2. Even though I am applying the transformation matrix, my shape is not showing up. I have attached all files here. Can you please let me know what may be going wrong? <attach all files>

Example of discouraged etiquette:

1) Hello @Nikolas Lamb <or> @Natasha Banerjee <hit enter, and then type next message, while TA or instructor has to wait>
2) @Nikolas Lamb <or> @Natasha Banerjee: I am having trouble with my code. <not attaching code or discussing trouble>
3) @Nikolas Lamb <or> @Natasha Banerjee: I am having trouble with writing the vertex shader for Assignment 2. Even though I am applying the

transformation matrix, my shape is not showing up. Can you please let me know what may be going wrong? <not attaching files>

If you want to have a Zoom session, let me know via Slack first, and I will initiate a Zoom session. **Please do not initiate Zoom sessions through Slack on your own.** Zoom sessions are available only 6pm to 7pm on T and Th.

8.5. Outside-of-office hours policy

Outside of office hours, you are free to either contact the TA or instructor directly on Slack through a private communication, or post a question in the lecture channels for public viewing. The TA or instructor will respond to your question through the channel you choose.

Please recognize that for Slack communication, you may not receive an instantaneous response, and plan for having enough time prior to submissions to solicit both in-office-hours and outside-of-office-hours help. However, both the TA and the instructor are committed to assisting you during and outside office hours, and will respond to your request in a reasonable time frame.

9. Course Evaluation and Grade Breakdown

Grade Breakdown for CS452/EE465

- Attendance: 10 points
- Lab assignments: 20 points (4 points per lab, to be done individually)
- 2-person programming projects: 20 points (10 points for Project 1, 10 points for Project 2)
- Midterm exam: 25 points
- Final exam (**held in week before dead week**): 25 points

Grade Breakdown for CS552/EE505

- Attendance: 10 points
- Lab assignments: 20 points (4 points per lab)
- Single-person self-proposed research-based project: 20 points
- Midterm exam: 25 points
- Final exam (**held in week before dead week**): 25 points

9.1. Grading Scheme

Final grades will be calculated by accumulating points according to the breakdown in Section 8.1, and will be awarded as follows:

A+ >=98 AND exceptional performance (A+ will be awarded sparingly)
A >=93.3
A- >=90
B+ >=86.6
B >=83.3
B- >=80

C+ >=76.6
C >=73.3
C- >=70
D >=60
F < 60

10. Assignment Submission

Assignments must be submitted to Moodle on the day and time they are due for full credit. Each assignment will come with a set of instructions on how the assignment should be submitted. Assignments may be submitted either as a .zip file containing all the required material, or as a .txt file containing a link to an online repository containing the material. **Please specifically consult the Academic Integrity and Cheating Policy if you intend to submit material through an online repository.** You should be reading the Academic Integrity and Cheating Policy regardless. You are recommended to keep your GitHub repository private. If you create a free publicly accessible Git repository, you stand the chance of having your code copied from (which, let us face it, is terribly unfair to you, so start protecting your code on the get-go). Lab assignments and projects must be turned in to Moodle by 11:55 PM on the due date. Late submissions receive a 0. Only under extenuating circumstances will this policy be revoked on a per student basis. For instance, having an exam on the due date or needing to go on vacation are not extenuating circumstances. Please communicate with the instructor if such circumstances arise.

11. Exams

The midterm will cover all material up to the class prior to the midterm date. The midterm will be offered prior to the assignment of midterm grades. The midterm date will be announced in class.

The final exam will cover all material up to the last day of class, and will be offered during the **week before dead week**. Please consult the course schedule on Moodle to see the exact date.

Students are expected to take the exam on the day/time the exam is scheduled. Students who have exigent circumstances must discuss with the instructor at least a week before the exam. If a student falls sick on the day of the exam, and cannot take the test, a letter from the Dean of Students must be sent to the instructor indicating that the student must be excused for not being able to take the exam.

12. Academic Integrity and Cheating Policy

Students are not permitted to submit the work of other students, books, papers, the Internet, or any other source as their own. Any published work belonging to other person(s) must be appropriately cited. The following are unacceptable:

- Two assignments submitted on Moodle that are exactly the same.
- An assignment that is exactly the same as code on an online repository such as

GitHub.
- Two assignments that are the same *in essence*. This means that if person A takes person B's assignment or project, and changes variable names and/or changes comments and/or changes the line spacing and/or shuffles content around from person B's assignment while keeping the results of the assignment or project intact and the code unchanged, then this is unacceptable.
- An assignment is the same in essence as code on an online repository such as GitHub.
- Large chunks of two assignments or projects are the same in essence.
- Large chunks of an assignment are the same in essence as code on an online repository such as GitHub.
- Online tutoring sources including but not limited to 'chegg' are absolutely **NOT** permitted under any circumstances for any assignment or project in this class.

If the instructor has provided code, only that code can be the same across different student assignments, and students will not be penalized for using instructor-provided assignment code, when it is appropriate.

If students are caught cheating or plagiarizing on the lab assignments, projects, or exam, they will be reported to the Academic Integrity Violation Committee for due action. If two assignments are found to have violated the academic integrity policy, both those assignments will be subject to these penalties.

Additionally, students found cheating will be subject to academic penalties and disciplinary sanctions under Clarkson's official regulations. Students are advised to consult Section IV of Clarkson's official regulations to find out information about rights, obligations, and procedures related to academic integrity.

13. Accommodation Policy

In compliance with Clarkson's policy and equal access laws, I am available to discuss appropriate academic accommodation for students. Students are encouraged to consult with the Office of AccessABILITY Services, located in the Student Success Center, ERC Suite 1400, to verify their eligibility for appropriate accommodation.

13.1. Accommodation in the event of extenuating circumstances, e.g., sickness

In the event that any student has extenuating circumstances, e.g., sickness or personal circumstances, the student is recommended to communicate with Dr. James Pittman, Dean of Students. Dr. Pittman will send out a memo to the instructor mentioning that the student is requesting accommodation. The memo will *not* contain the reason for accommodation, in order to protect the privacy of the student. The instructor will *not* enquire the nature of the accommodation from the student to protect their privacy. The instructor will work with the student on a one-to-one basis to address the accommodation, and will provide extension on assignment or make-up for an exam as

discussed in section 10 on exam make-up policy.

14. Expected Etiquette for Interaction

In the spirit of inclusion and maintenance of a safe and professional environment for all students, inappropriate conduct in in-person and online environments will absolutely not be tolerated in this class. Inappropriate conduct includes but is not limited to in-class bullying; cyberbullying; posting of vulgar and/or inappropriate content in Zoom sessions, Slack, Moodle, and/or email; downloading of unapproved apps in Slack; using of vulgar and/or inappropriate language in class, Zoom sessions, Slack, Moodle, and/or via email; invitation of unauthorized individuals to Slack or Zoom; and showing intolerance toward the opinions of your teammate, your fellow classmates, the TA, and/or the instructor. A spirit of debate is highly encouraged, and there are immense opportunities for pointing out of errors or scope for improvement. However, as you will notice, there is a diverse array of students in the class, from a range of backgrounds, and pursuing a variety of majors. This enriches our environment greatly, but also necessitates that students have respect for each other.

To make everyone in the class accountable, the Slack workspace will be continuously monitored by the instructor. Students will not be able to make channels, and students cannot install apps or invite other individuals without the consent of the. Once a message is posted, you will have a short period of time in which to edit it. However, messages cannot be deleted from the Slack workspace. Note that this is being done to discourage posting of inappropriate content, but having civil discussions and asking questions is highly encouraged --- in this class where all of us are learning new ideas on how to promote effective collaboration between humans to create new software technology, there is no such thing as a silly question. Please feel free to use the Slack workspace to deliberate on how to effectively work in teams, not just with your teammate (for undergraduates) or the instructor, but with the entire class at large.

15. Expected Etiquette for Safety

As a reminder, you are required to follow all CDC, state, and university mandates and guidelines for COVID-19 safety. Outside of office hours, you are not to come within 6 feet of me unless I explicitly permit you to do so, and you are requested to follow safe practices with all your fellow students and the campus community. Students found in violation of university mandates or the mandates placed in the syllabus will be reported to the Dean of Students

You are not only recommended, but also encouraged, to collaborate with your teammate through the online collaboration and project management approaches that will be discussed in class. Strengthening your skillset in collaborating online will make you well-prepared for the evolved technology workforce where hybrid mode operation with work-from-home option is now rapidly becoming the norm.

16. Disclaimer

The instructor retains the right to amend the course evaluation, grade breakdown, and grading scheme during the semester to adapt it to the needs of the course. Changes to the syllabus will be announced in class, and will be updated on Moodle.