Course Syllabus

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CSS 551: Advanced 3D Computer Graphics

UW1-030

Tues/Thurs 5:45pm-7:45pm

COVID-19 Related Resources

Face covering policy: **(https://www.uwb.edu/academic-affairs/covid-policies)** As we return to in person instruction, I want to acknowledge the difficulties of this past 18 months and inform you of my expectations for our safety as we begin this class together. To ensure the health and safety of the University campus community, face coverings are required to be worn indoors when other people are present regardless of vaccination status, and in all public and common areas, such as lobbies, hallways, stairways, restrooms, elevators, and classrooms. Eating and drinking in the classroom will not be permitted This requirement is in accordance with the University of Washington COVID-19 Face Covering Policy. For the purposes of this policy, a face covering must: Fit snugly against the sides of the face; completely cover the nose and mouth; bandanas and gators are not considered face coverings for this policy. Students who do not wear a face mask will be asked to leave the classroom. If you forget your face mask or refuse to wear one, I will ask you to leave the classroom. Repeated failure to wear a face covering may result in you being referred to the Student Conduct Office for possible disciplinary action. I hope that we can all agree to keep each other safe by wearing our face masks. **Note:** According to **Exemption-e of the UW face covering policy (https://www.ehs.washington.edu/system/files/resources/COVID-19-face-cover-policy.pdf)**, if and when I can maintain a minimum of six feet distance from everyone else in class, I may choose to remote my mask while lecturing to ensure everyone in class can hear me well.

This is a in-person class. If necessary, the class will continue as remote learning. In all cases, you can join the class **via zoom at this link**   **(https://washington.zoom.us/j/94131458064?pwd=WTFLc1Q1TWUwV3M1VUIGY3N3eWIrZz09)** , I will upload the **recordings after class to this folder (https://drive.google.com/drive/folders/1UdpEFO5dbRJ7GvZJWyT7gNKq1Q-GX26c)** . Here are some **details of Zoom remote learning (https://docs.google.com/document/d/1Wutj7AOKPEvDakgK5lk2M23BCemtYQ5gIKLghI0df5M/edit#heading=h.gk1fw0cv0pr9)** .

UW Bothell Coronavirus (COVID-19) resources: **https://www.uwb.edu/coronavirus (https://www.uwb.edu/coronavirus)**

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Office: I will be at **this Zoom URL (https://washington.zoom.us/j/93158292951?pwd=bE1wc3RKUHdabkdWVGxWak44cHIKUT09%20)** during office hours (passcode: 1234).

Office Hours: Mon 12-2pm (or email for appointment)

Course Description

Introduces practical and popular three-dimensional (3-D) graphic algorithms. Examines modeling (how to build 3-D objects), animation (how to describe the motion of objects), and rendering (how to generate images of 3-D objects in animation).

In this class, we will learn about the essence of 3D interactive applications including: user interface, virtual cameras and their manipulations, review of basic applied linear algebra, mesh and related data structures, hardware shading language, illumination model, texture mapping, and some foundation modeling techniques such as rotational sweeps. We will use Unity3D as the vehicle for learning these concepts. After this class, students are expected to understand the basic computer graphics terminology, concepts, algorithms, and be able to design and implement 3D interactive computer graphics related programs.

NOT GOALS: We are *not* here to learn DirectX, OpenGL, XNA, GLUT, FLTK, MFC (Microsoft Foundation Classes), WPF, Swing, WinForm, Java, C, C++, or Unity3D etc. These are all transient technologies!

GOALS: The primary goal of this class is to ensure that, given *typical GUI* and *graphics API*, students will be able to design and implement interactive applications based on real life user requirements.

Prerequisites: Graduate standing, or CSS342 with a grade of C of better; may not be repeated.

Course Objectives

The objectives of this course are for students to:

- Study the Model-View-Controller (MVC) software architecture and its support for implementing interactive graphical applications
- Understand the essential conceptual areas of 3D computer graphics: modeling, animation, and rendering
  - Modeling: Coordinate transformation pipeline, basics of hierarchical modeling, mesh representation
  - Animation: simple linear interpolation
  - Rendering: illumination models
- Learn the programming model of modern 3D graphical Application Programming Interface (API)
  - Issues behind 3D API design
  - Device initialization
  - Vertex and Pixel shaders
- Practice the graphics concepts learned based on a graphical API

Course Learning Outcomes

Upon successful completion of the course, students shall be able to:

- Discuss how MVC software architecture can support the implementation of 3D graphical applications.
- Describe popular interactive graphical software systems (e.g., Microsoft Powerpoint, or Adobe Photoshop) in the context of MVC architecture.
- Discuss the programming model of contemporary graphical API (e.g., OpenGL, Direct3D, or XNA).
- Design and build 3D interactive graphical applications that supports:
  - Real-time user control and manipulation of graphical scenes
  - Graphical scenes with multiple camera views of 3D models
  - 3D models organized as scene nodes in scene graphs with multiple transformable components
  - 3D models rendered by custom vertex and pixel shaders with basic effects including: Lambertian and Per-pixel Phong illumination based on simple light source types (e.g., point, directional, and spot-light).
  -

Grading

Programming Assignments (6)	~65%
Weekly Quiz + Classroom Participation	~15%
Final Project	~20%

Books

Required Text: we don't have one. We will read different chapters from different books. I will post the reading material on our course website based on chapters from the following textbooks:

Required Readings:

- **A:** *Essentials of Interactive Computer Graphics*, Kelvin Sung, Peter Shirley, Steven Baer, Wellesley, MA., A K Peters Ltd, 2008.
  - **A1:** Chap 1, 2 to 2.3, 5 & 6: Event Programming + GUI + MVC
  - **A2:** Chap 8 & 9: Transformation and compositing transforms
  - **A3:** Chap 11: Hierarchical Modeling
  - **A4:** Chap 12: Blending + Texturing
  - **A5:** Chap 13: Simple 3D Scene Construction
  - **A6:** Chap 14: 3D Viewing Volumes
  - **A7:** Chap 15: Camera Manipulations
- **B:** *Real-Time Rendering*, Third Edition, Tomas Akenine-Moller and Eric Haines, AK Peters, 2008.
  - **B1:** Chapter 2: Rendering Pipeline
  - **B2:** Chapter 3: GPU + Shader
- **C:** *Interactive Computer Graphics – A Top-Down Approach With OpenGL*, fourth edition, Edward Angel, Addison Wesley, Boston, 2006.
  - **C1:** Chapter 6: Illumination and Lighting
- **D:** *Graphics Shaders: Theory and Practice,* Mike Bailey and Steve Cunningham, AK Peters, 2009.
  - **D1:** Chapter 1 and 2: GPU + Rendering Pipeline
- **E:** *3D Math Primer for Graphics and Game Development*, Fletcher Dunn, and Ian Parberry, Wordware Publishing, Inc., 2002.
  - **E1:** Chapter 4 and 5: Vector Math
  - **E2**: Chapter 13: Geometric Tests (intersections)
- More may follow

General References:

- *Fundamentals of Computer Graphics*, Forth edition, Steve Marschner and Peter Shirley, CRC Press, 2016.
- Interactive Computer Graphics – A Top-Down Approach with WebGL, 7th edition, Edward Angel and Dave Shreiner, Addison Wesley, Boston, 2015.

Approximated Schedule

Week	Topics	Reading	Date	Notes
1	Intro and GUI	A1	Sep 30	Assign: MP1
2	MVC Framework and ECS of Unity3D Math for 3D Graphics	A5, E1, E2	Oct 5 Oct 7	**Due**: MP1 Assign: MP2
3	Transformation Operators + Rotation in 3D Viewing Volume + Camera Manipulation	A2, A6, A7	Oct 12 Oct 14	**Due**: MP2 Assign: Tech Investigation Assign: MP3
4	Shading Architecture + HLSL Graphics Pipeline + World Matrix + View Matrix	B, D	Oct 19 Oct 21	
5	Pivoted Transformation + Rotation in 3D Hierarchical Modeling	A3	Oct 26 Oct 28	**Due**: MP3 Assign: MP4
6	Modeling: Index Primitives + Rotation Sweep		Nov 2 Nov 4	~~Due: Tech Investigation: source + video~~

7	~~Tech Investigation Presentation~~ Modeling Continue + Catch up *No class (Veteran's Day)*		Nov 9 Nov 11	~~Due: MP4~~ ~~Assign: MP5~~ **Due:** Tech Investigation: Source + video
8	**Tech Investigation Presentation** Illumination Models ~~Final Project Presentation~~		Nov 16 Nov 18	**Due**: MP4 Assign: MP5 + Final Project
9	**Final Project Proposal Presentation** + Illumination Models Continue *No class (Thanksgiving break)*	C	Nov 23 Nov 25	~~Due: MP5~~ **Due:** Final Project Proposal
10	Texture Mapping: Placement + Filtering Shader Effects: Reflection + Shadow	A4	Nov 30 Dec 2	**Due:** MP5
11	**Guest Lecture**: Di Wang (Amazon), working with Computer Graphics in the industry **Final Project Progress Demo**	Online References	Dec 7 Dec 9	**Due**: Final Project Progress Demo
12	Finals Week: Final Project due		Dec 14	**Due**: Final Project

Submitting Programming Assignments (MPs)

Submitting Source Code: You will submit your source code of each programming assignment (or machine problem, or mp) and the grader will run/test your submissions. We will be using the canvas facility (refer to the course web-site for the canvas submission link). There is a folder with the corresponding mp number on the submission site (e.g. mp1, mp2, etc.). Before the due time of the assignment, you should:

- Create a folder containing all the relevant *source files* of your mp and a folder containing the build results of your project (the exe file and the corresponding assets). Failure to include the build folder will *result in lost credits*.
- Use your first and last name and mp# as the name of your folder. Please *do not include blank space* as part of the name for this folder (i.e. *do* use "KelvinSungMp1" as folder name, and *do not* use "Kelvin Sung MP1" with blank spaces.)
- Please zip up our folder into one zip file. Go to our course submission area and "turn in" you .zip file.
- Submit as many times as you wish, the grader will only look at the last one received before the deadline. Please *do not* submit hard copies of your program. Let's safe some trees, we will look at your source code electronically.

There is a "*Test Turn-in*" assignment for you to *try things out*. Please do try it before the first MP due date! If I do not see a test submission *and* you have trouble submitting your first assignment at the last minute, I *will not* help you. I can only help those who tried.

In addition, and **very importantly**, you should always download your submission, un-zip/run/open-in-editor to ensure your submission is correct. Remember, the grader will download your submission, unzip, double-click on the .exe file to run. If the grader cannot download, double click and run your program, you will receive a zero. You have been warned.

You are responsible to ensure that the files you submitted are correct. On the due date of the mp, the corresponding directory will be *close* at precisely the due time. After which, you *will not be able to submit your work*! We *will not* accept submissions via emails. You are responsible to ensure that the files you submitted are correct. Minor submission mistakes (e.g. missed a small file) will result in significant deduction from the assignment. Major submission mistakes (e.g. forgot to include a major source code file) will be treated as incomplete assignment and you will get *0%* for the assignment. On a case-by-case basis, I will decide if a submission mistake is minor or major. There will be no exceptions!

If there is an emergency and/or personal difficulty, please talk to me in person. Remember to document your code, and practice the good programming skills.

Sharing of Your Final Projects

I am proud of students' accomplishments and would very much like to share them, if allowed. Towards the end of the quarter I will inquire for your permissions to share your final projects publicly, e.g., **via websites similar to this** (https://myuwbclasses.github.io/CSS451/) . At that point, you should feel free to decide to grant me the permission or not. Your decision on this will have absolutely no impact on your performance in this class. I will respect your decision and only post your results if you grant me the permission.

General Policies

Assignment Deadlines: There will be no late assignments accepted. Let me put this in another way, there will be no late assignments accepted. This is the case for both homework assignments and machine problems. Pay attention to the deadline on the assignments (including the time), there will be no late assignments accepted. Let me explain this again, there will be no late assignments accepted. I am actually a reasonable person, come talk to me about exceptional circumstances. You know the deadlines now please plan ahead.

Lateness to classes: It does not bother me, just don't disturb anyone. If you want to leave early, it would be very nice if you could give me advance warning. If that's too much trouble, or if you forgot, don't worry, just don't disturb anyone and leave quietly.

Commitments and such: I am usually very easy going. I like relaxed classrooms for learning and will try my best to create such an environment. Please do not confuse relax environment with relax requirements. I work hard, and expect students to work as hard. On average, each percentage of your assignments should represent one-two hours of outside-of-class time. For example, if an MP worth 8%, then on average, you will probably need about 10-15 hours to finish this assignment. Please use this as a reference and let me know if you are spending too much time on the assignments. If most of you are experiencing the same problem, then we will have to adjust the amount of work. Please consider if you have the time this quarter for this class. If you do have the time, please stay in this class, I will work hard and try my best to make this class a worthwhile learning experience for you.

Group Assignments: The final project is a group assignment. You **must** form groups of two (or three if there is a left over person) to work on the final project. No groups can be less than two members.

Problems

If you have any problem with this course, please talk to me as soon as possible. I would like to help in any way I could, but I have to know there is a problem. If you fall behind in this class, it will be difficult to catch up.

Special Needs

If you believe that you have a disability and would like academic accommodations, please contact **Disability Resources for Students (http://www.uwb.edu/studentservices/drs)** (UW1-175) at 425.352.5307 or at **drs@uwb.edu (mailto:drs@uwb.edu)** . In most cases, you will need to provide documentation of your disability as part of the review process. I will coordinate with the University to ensure that the appropriate accommodations are made in this class.

Access and Accommodations: Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact **Disability Resources for Students (http://www.uwb.edu/studentservices/drs)** (UW1-175) at 425.352.5307 or at **drs@uwb.edu (mailto:drs@uwb.edu)** . DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s), and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

For Our Veterans: If you are a student who has served in our nation's military forces, welcome home, and thank you for your service. I hope that you feel comfortable enough to confidentially self-identify yourself to me so I can help you make a successful transition from the military to higher education.

Religious Accommodation Policy: Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at **Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/)** (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/) . Accommodations must be requested within the first two weeks of this course using the **Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/)** (https://registrar.washington.edu/students/religious-accommodations-request/) .

Academic Conduct

Student Code of Conduct: **http://apps.leg.wa.gov/WAC/default.aspx?cite=478-120** (http://apps.leg.wa.gov/WAC/default.aspx?cite=478-120) :

"*The university is a public institution having special responsibility for providing instruction in higher education, for advancing knowledge through scholarship and research, and for providing related services to the community. As a center of learning, the university also has the obligation to maintain conditions conducive to freedom of inquiry and expression to the maximum degree compatible with the orderly conduct of its functions. For these purposes, the university is governed by the rules, regulations, procedures, policies, and standards of conduct that safeguard its functions and protect the rights and freedoms of all members of the academic community.*"

…

"*An instructor has the **authority to exclude a student from any class session** in which the student is disorderly or disruptive. If the student persists in the disorderly or disruptive conduct, the instructor should report the matter to the dean of the school or college, or, at the University of Washington Bothell and Tacoma campuses, to the dean or director of the program in which the student is enrolled.*"

Academic Integrity and Plagiarism: See **http://www.uwb.edu/studentservices/academicconduct** (http://www.uwb.edu/studentservices/academicconduct)

for crucial information regarding academic integrity. The library also has an extremely useful website with resources at **http://libguides.uwb.edu/ai** (http://libguides.uwb.edu/ai) . You are responsible for knowing what constitutes a violation of the University of Washington Student Code, and you will be held responsible for any such violations whether they were intentional or not. Plagiarism is one of the most common violations of academic integrity, so please pay attention to both the web information and when your instructor explains all of this in class. In short, do your own work, and clearly cite all your sources. If you are unsure, ask for help!

Privacy: The opinion you expressed (in class discussion, in written assignments, on our course discussion board), are yours. None of this information will be shared with anyone, not even your parents.

Other potentially useful/important information

Inclement Weather: Please check if the campus may be closed due to weather. Information about suspension of operations will be made public and available through the media. Students can learn of campus operations status from the website or by calling the Campus Information Hotline 425.352.3333. You may also sign up with an alert system that will contact you via email or text message if classes are canceled. For more information on the alert process, please see **https://www.uwb.edu/emergency** (https://www.uwb.edu/emergency) (http://uwb.edu/alert) . Class activities will be rescheduled as needed.

Student Support Services:

IT Helpdesk: **IT@uwb.edu (mailto:IT@uwb.edu)** , 425-352-3456
Library: **http://library.uwb.edu/** (http://library.uwb.edu/) 425-352-5340
Writing Center: **www.uwb.edu/WritingCenter/** (http://www.uwb.edu/WritingCenter/) 425-352-5253
Quantitative Skills Center: **http://www.uwb.edu/qsc** (http://www.uwb.edu/qsc) 425-352-3170
Student Success Services: **http://www.uwb.edu/cusp/studentsuccess** (http://www.uwb.edu/cusp/studentsuccess) 425-352-3776
Career Services: **http://www.uwb.edu/careers** (http://www.uwb.edu/careers) 425-352-3706

Student Counseling Services: **http://www.uwb.edu/studentservices/counseling**   **(http://www.uwb.edu/studentservices/counseling)**   425-352-3183

Course Summary:

Date	Details	Due
Sun Oct 3, 2021	📝 **Quiz 0: On Syllabus** **(https://canvas.uw.edu/courses/1492345/assignments/6667685)**	due by 11:59pm
Wed Oct 6, 2021	📝 **Test Turn-in** **(https://canvas.uw.edu/courses/1492345/assignments/6667709)**	due by 5:40pm
Sat Oct 9, 2021	📝 **MP1: Getting to know the tools and weekend entertainment** **(https://canvas.uw.edu/courses/1492345/assignments/6667704)**	due by 11:59pm
Sun Oct 10, 2021	📝 **Quiz 1: Basic Unity Knowledge** **(https://canvas.uw.edu/courses/1492345/assignments/6667689)**	due by 11:59pm
	📝 **Quiz 2: Unity Objects and Components** **(https://canvas.uw.edu/courses/1492345/assignments/6754735)**	due by 11:59pm
Thu Oct 14, 2021	📝 **2021-10-14 on Vector: Chapter 4 (Intro to Vectors)** **(https://canvas.uw.edu/courses/1492345/assignments/6769093)**	due by 7:30pm
Sat Oct 16, 2021	📝 **MP2: GUI and Simple MVC** **(https://canvas.uw.edu/courses/1492345/assignments/6667705)**	due by 11:59pm
Sun Oct 17, 2021	📝 **Quiz-3: MVC** **(https://canvas.uw.edu/courses/1492345/assignments/6667688)**	due by 11:59pm
Tue Oct 19, 2021	📝 **2021-10-19: More on Vectors** **(https://canvas.uw.edu/courses/1492345/assignments/6776615)**	due by 7pm
Thu Oct 21, 2021	📝 **2021-10-21: Chapter 5 (Dot Product)** **(https://canvas.uw.edu/courses/1492345/assignments/6779972)**	due by 6:30pm
Sun Oct 24, 2021	📝 **Quiz 5: For Weighing Quiz 4** **(https://canvas.uw.edu/courses/1492345/assignments/6667690)**	due by 11:59pm
Tue Oct 26, 2021	📝 **2021-10-26 on Vector Line Equation** **(https://canvas.uw.edu/courses/1492345/assignments/6792202)**	due by 6:30pm
	📝 **2021-10-26: Chapter 6 (Cross Product)** **(https://canvas.uw.edu/courses/1492345/assignments/6790139)**	due by 6:30pm
	📝 **Quiz 4: The Math We learned** **(https://canvas.uw.edu/courses/1492345/assignments/6667686)**	due by 11:59pm
Sun Oct 31, 2021	📝 **Quiz 6: Matrices and Transformations** **(https://canvas.uw.edu/courses/1492345/assignments/6667684)**	due by 11:59pm
	📝 **MP3: Fun With Vectors** **(https://canvas.uw.edu/courses/1492345/assignments/6667706)**	due by 11:59pm

Date	Details	Due
Tue Nov 2, 2021	📝 **2020-11-02: Concatenation of Transform Operators** (https://canvas.uw.edu/courses/1492345/assignments/6804507)	due by 6:30pm
Thu Nov 4, 2021	📝 **2021-11-4: Pivoted Transform** (https://canvas.uw.edu/courses/1492345/assignments/6809227)	due by 6:30pm
Sun Nov 7, 2021	📝 **Quiz 7: SceneNode Hierarchy** (https://canvas.uw.edu/courses/1492345/assignments/6667687)	due by 11:59pm
Sat Nov 13, 2021	📝 **Final Project Technology Investigation** (https://canvas.uw.edu/courses/1492345/assignments/6667702)	due by 11:59pm
Sun Nov 14, 2021	📝 **Quiz 8: The SceneNodeControl UI Object** (https://canvas.uw.edu/courses/1492345/assignments/6667691)	due by 11:59pm
Sat Nov 20, 2021	📝 **MP4: SceneNode and Camera** (https://canvas.uw.edu/courses/1492345/assignments/6667707)	due by 11:59pm
Sat Dec 4, 2021	📝 **MP5: Simple Modeling + Direct Object (Transform) Manipulation** (https://canvas.uw.edu/courses/1492345/assignments/6667708)	due by 11:59pm
Wed Dec 15, 2021	📝 **Final Project: Please submit all materials to your g-drive folder** (https://canvas.uw.edu/courses/1492345/assignments/6667697)	due by 11:59pm
	📝 **Extra Credit** (https://canvas.uw.edu/courses/1492345/assignments/6667694)	
	📝 **Final Project Final Demo [Kelvin Eval]** (https://canvas.uw.edu/courses/1492345/assignments/6667695)	
	📝 **Final Project Final Demo[Peer Eval]** (https://canvas.uw.edu/courses/1492345/assignments/6667696)	
	📝 **Final Project Progress Demo [Kelvin Eval]** (https://canvas.uw.edu/courses/1492345/assignments/6667698)	
	📝 **Final Project Progress Demo [Peer Eval]** (https://canvas.uw.edu/courses/1492345/assignments/6667701)	
	📝 **Final Project Proposal [Kelvin Eval + Proposal]** (https://canvas.uw.edu/courses/1492345/assignments/6667700)	
	📝 **Final Project Proposal Presentation [Peer Eval]** (https://canvas.uw.edu/courses/1492345/assignments/6667699)	
	📝 **For recording Final Video** (https://canvas.uw.edu/courses/1492345/assignments/6667703)	
	📝 **In class exercise on Week 2: Model View Controller** (https://canvas.uw.edu/courses/1492345/assignments/6763025)	