

COMP 4482A/9511A, Fall 2022

Game Programming

Syllabus

Course Information

Overview

This course will provide a high-level look at the design, implementation, and usage of video game engines. The primary goal of this course is to offer a basic understanding of (i) the requirements of programming for video games and (ii) the systems required to create a usable and reusable foundation for game development. Extra time will be spent examining and working in existing game engines in order to demonstrate good (or bad) design.

Some focus will be given to the graphical nature of game engines and will therefore include an introduction to computer graphics, (similar to and expanding on CS3388), shaders, animation techniques, and optimization algorithms. Depth will be given in selected areas, but the student will be expected to do a reasonable amount of independent reading and learning outside of the lecture hours.

Calendar Description

Core concepts and techniques of game programming, including the development and usage of game engines for the creation of games. Topics from: game engine architecture; real-time 2D and 3D rendering; character animation; shaders; real-time physics simulation, artificial intelligence, and networking; procedural methods; player input and controls; platform considerations; tools development.

Prerequisite Requirements

- CS 3307 (Basic Software Engineering) or SE3350.
- CS 3305 (Operating Systems) or SE3313.
- CS 3340 (Algorithms I) or (SE2205 and SE3310).
- Math 1600 (Linear Algebra I), or Applied Math 1411.

Useful (Not Mandatory) Background Knowledge

- Working knowledge of multivariate calculus and linear algebra.
- Ability to code well in Object-Oriented C-like languages (C#, C++, Java).
- Experience coding with graphics and/or the OpenGL graphics API.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Teaching Staff + Office Hours

Alex Brandt
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Mondays, 15:00 - 16:00

Teaching Assistants

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Email Contact

Students must use their Western (@uwo.ca) email addresses for communicating with teaching staff. Include “CS4482” in the subject line or else your email may not receive a reply.

Course Materials and Website

There is no required textbook for this course. Students are responsible for checking the course OWL site on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Some interesting supplemental material:

- *Game Engine Architecture*, Second or Third Edition, by Jason Gregory.
- *GPUGems*, *GPUGems2*, *GPUGems3*: <https://developer.nvidia.com/gpugems/>.

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Class Schedule

Monday 12:30 - 14:30 **NCB-114**
Wednesday 12:30 - 13:30 **NCB-114**

First class: September 12

Last class: December 7

There is no class October 10, October 31, or November 2.

In the event of a COVID-19 resurgence which requires moving away from in-class teaching, lectures will proceed synchronously via Zoom. Details to be announced, if required. The grading scheme will not change. Any remaining assessments will also be conducted online.

Course Topics

This is a list of possible course topics. We will cover a subset based on the interests of the class and time constraints. Topics will not necessarily be presented in the order listed here.

- History of Game Development
- Unity 3D - A Game Engine
- Programming for the *Nintendo DS* console.
- Game Engine Development - Common Systems & Pitfalls
- Game Engine Tools
- User Interface, User Experience Design
- Real-Time Rendering
 - Character Animation: Explicit and Implicit
 - Shading: Lighting models, NPR, Shadows, Full-screen effects,
- Physics Engines, Simulations
 - Kinematics, Kinetics, Collisions.
- Multiplayer Gaming

As there simply is not enough class time to teach the above topics in detail, the course will proceed in a “breadth-first” manner. For many of the topics, we will provide references to material you already know from your basic CS education, along with instruction on how to apply that knowledge to the domain of video games. We will provide a starting point and a helpful push. To get the most out of these topics, and apply the topics of interest to your projects, you will have to do some study on your own.

Student Evaluation

Most of a student’s mark comes from applying what is learned in and out of class to a progressive series of assignments. There are three primary ‘streams’ of assignments: *Game Programmer*, *Engine Developer*, and *Tools Programmer*. Students may pick and choose which assignments they wish to complete according to their interests and career aspirations. The only constraint is that the student must have completed **and passed** all “pre-requisite assignments” before submitting another assignment. Assignments within a single branch may *not* be completed concurrently. Figure 1 shows these branches and prerequisite structure ; it’s a *skilltree*.

Each assignment has an “experience point value” (XP for short). Completing the assignment results in the student being awarded the associated amount of XP. *Note that there are no specific grades given for assignments, they are strictly pass/fail.* If you meet the specified requirements for the assignment, you pass, and are awarded the associated XP. In this case, a “**pass**” corresponds to roughly an 80% in a traditional marking scheme. Occasionally, a particularly awesome assignment may be awarded “bonus XP”.

If you do not meet the requirements of the assignment, you will be informed which requirements were not met and you will receive no XP. However, you may continue to modify and resubmit your assignment until you pass, or until the final deadline, whichever comes first. **The strict final deadline is Thursday, December 8th, at 23:55**, no re-submissions will be accepted after that time (see **Assignment Schedule** below). Any remaining failing submissions will be graded on a standard 0-100% scale for partial XP.

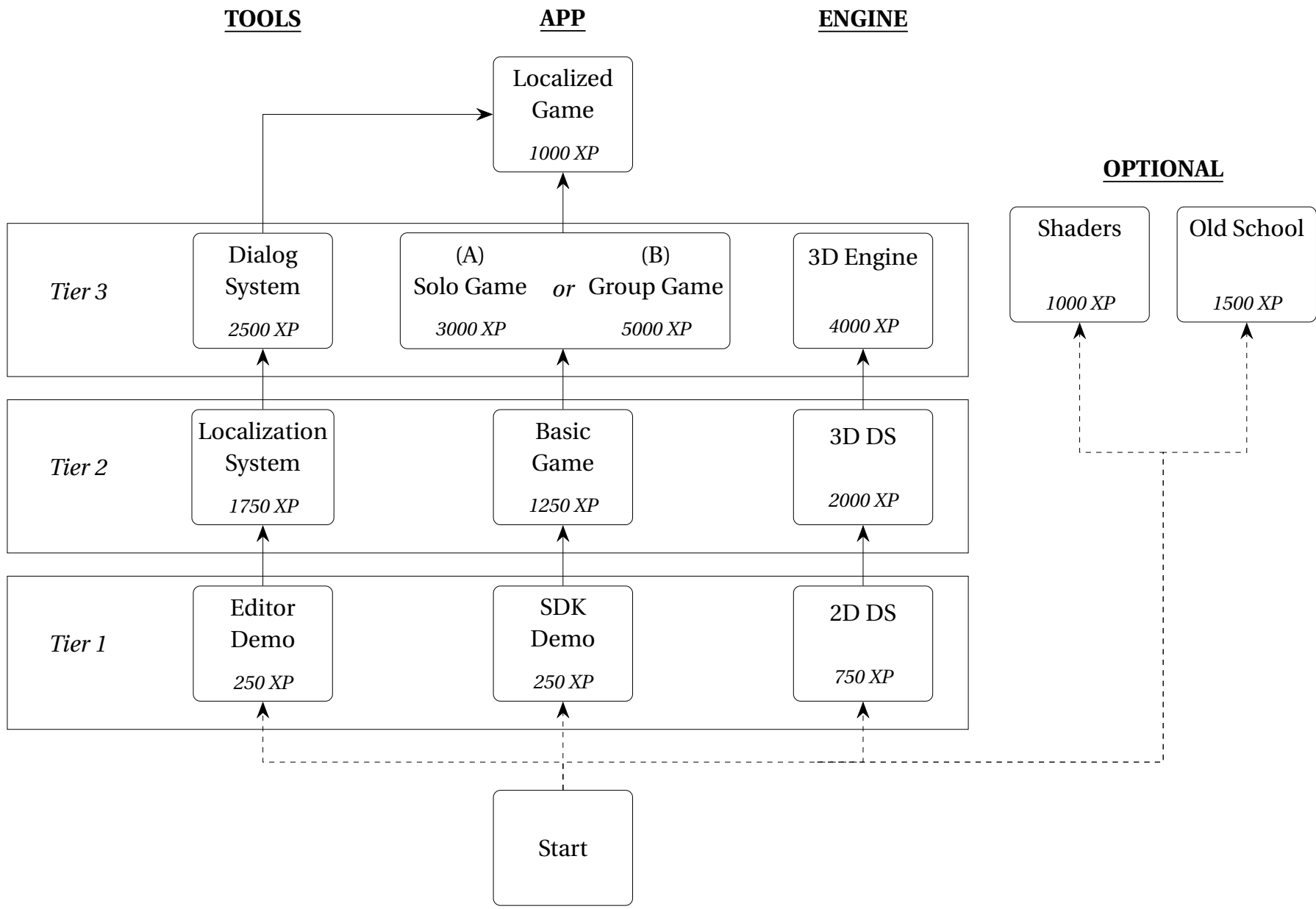


Figure 1: CS 4482 Skill Tree.

Computing your final grade

Every good RPG has an "XP curve". In this course, your final grade follows a simple XP curve:

$$\text{Current Grade} = \sqrt{XP}.$$

That's it. That's your mark in the course. You add up the XP you've earned so far and take the square root. There is no final exam and the assignments are all pass/fail. This means there is *no* nondeterminism in your grade. You can decide, right now, which assignments you're going to do and, if you put in the work, you know *exactly* what your final grade will be.

WARNING: READ THIS

The important consequence of this marking scheme: make sure you plan to do (at least) one of the Tier-3 assignments at the end of a particular skill tree and proceed accordingly. The goal of the skill tree system is to provide flexibility for students with different interests. Under no circumstance should you plan to complete every assignment in the skill tree... unless you are independently wealthy, don't work, have no other classes, or really like learning under stress.

Suggested Paths

At a minimum, each student should complete at least one "tier 3" assignment. Some suggested paths, and their resulting final grade are shown below. You are free to choose any combination of assignments (as long you meet the prerequisites), but here are some combinations I suggest.

- Basic Gamer (67%): **App 1, 2, 3a**. You like games, and you want to have a fun semester, but don't want to do that much work.
- Basic Front-End (67%): **Tools 1, 2, 3**. You like user interfaces, accessibility, and front-end development.
- Basic Back-end (82%): **Engine 1, 2, 3**. You're not afraid of C++ or OpenGL. You like software design, graphics, and *how* games work.
- The Group Gamer (80%): **App 1, 2, 3b**. You like games and teamwork. With one or two teammates, create a *great* game.
- The Recommended (85%): **App 1, 2, 3a; Tools 1, 2**. This is the recommended path. It gives a great mark in the course and great learning opportunity for making games and using game engines.
- The Apprentice (95%): **App 1, 2, 3a; Tools 1, 2, 3**. You like games and you like making games. Making games is more than just making games; you need to make games and make tools which helps team members contribute more effectively to making games.
- The Adept (100%): **App 1, 2, 3a, 4; Tools 1, 2, 3**. You are looking forward to a career in the video game industry. This path gives you the most experience in making games and using video game engines.
- Graphic Gamer (100%) **App 1, 2, 3a; Engine 1, 2, 3**. You are looking forward to a career in the video game industry. This path gives you the most experience in making games and game engines.

This non-traditional grading scheme is frightening to me. What can I do?

Ignore everything above and come see me. We can decide together which assignments are best for your interests and which will give you an overall great mark in the course.

Assignment Schedule

There is a great deal of flexibility in assignment choice in this course and with that flexibility comes great responsibility. Much like the real world, you must manage your time accordingly for the different tasks involved in completing your projects. The (not-so) secret evaluation mechanism of this course is time-management.

Due to the mix-and-match aspect of this evaluation approach there are no firm due dates (*except December 8, 23:55*) you can attempt every assignment from day 1, submitting and re-submitting until you pass. **However**, it is expected that you submit assignments regularly throughout the term to show progression and engagement with the assignments. In particular, you must meet the following deadlines.

- **Tier 1:** Friday, September 30, 2022, at 23:55.
- **Tier 2:** Friday, October 28, 2022 at 23:55.
- **App 3 Proposal:** Monday, November 7, 2022 at 23:55.
- **Tier 3:** Friday, December 2, 2022 at 23:55.
- **Tier 4:** Friday, December 2, 2022 at 23:55.
- **Optional:** Friday, December 2, 2022 at 23:55.
- **All submissions and re-submissions must be made by Thursday, December 8th, 2022 at 23:55.** No re-submissions or modifications will be permitted following this date.

Late Assignments

This course offers unlimited *re*-submissions until you pass an assignment. Due to the time required for marking, an assignment's submission date is based on the date of its *first submission*. A submission made on time, but which fails, will **not** be penalized if re-submitted *after* the due date. However, "place-holder" submissions will not be accepted. That is, making an empty or near-empty submission before the deadline to avoid a late penalty is unacceptable. Such a place-holder submissions will be considered void and late penalties will be applied.

Late Penalties:

- **Tier 1, Tier 2:** 50% of its XP
- **Tier 3, Tier 4, Optional:** No guarantee for re-submission.

Note on re-submissions. Any assignment submitted before December 2, 2022 at 23:55 will be returned before December 8 and therefore be eligible for re-submission. Any assignment submitted after December 2 will be marked on a first-come, first-served basis, and as human resources allow. If you submit after December 2, you are not guaranteed to have your assignment returned in time to re-submit by December 8.

Academic Consideration for Student Absence

Tier 1, Tier 2, Optional

Students should contact the instructor directly via email to arrange accommodation. If approved, the accommodation will be to waive the late penalties. Given the flexible nature of this course and evaluation scheme, accommodations for missing these deadlines must be requested sufficiently early. For example, it is *not* feasible to complain about an illness on October 1, 11:52pm, and ask for an extension. Contact the instructor **48 hours** before any deadline, except in truly exceptional circumstances, to discuss your options.

Tier 3, Tier 4

Students must contact the academic counselling office of their home Faculty. Students will need to provide a Student Medical Certificate if the absence is medical, or provide other appropriate documentation. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. All documentation required for absences must be submitted to the Academic Counselling office of a student's Home Faculty

For the policy on Accommodation for Medical Illness - Undergraduate Students, see: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf and for the Student Medical Certificate (SMC), see: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

Religious Accommodation

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar: <https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>

Policies, Accommodation, Accessibility

Mental Health

Mental and emotional well-being is highly important and should not be treated lightly. Students who are in emotional/mental distress should refer to Mental Health@Western at <http://www.uwo.ca/uwocom/mentalhealth/> for a complete list of options about how to obtain help.

Accessibility

Students with disabilities should work with Accessible Education (formerly SSD), to seek accommodation based on medical documentation or psychological and cognitive testing. Please see the policy on Academic Accommodation for Students with Disabilities.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at (519) 661-2147 if you have any questions regarding accommodations.

Ethical Conduct

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at this web site.

All required assignment submission may be subject to submission for similarity review to open-source and commercial plagiarism detection software under license to the University for the detection of plagiarism. This may include MOSS and turnitin. All submissions for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com

Student Support

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters.

The Student Development Centre provides learning skills services for students. Other services are also provided by the University Students' Council

Registration Services

Refer to the Registrar's website for information and services involving registration.