

**Carleton University**  
**School of Computer Science**  
**COMP 4501: Advanced facilities for real-time games**  
**Winter 2020**  
**Course Outline**

**Contact**

Instructor: Oliver van Kaick

E-mail: [Oliver.vanKaick@carleton.ca](mailto:Oliver.vanKaick@carleton.ca)

TA: TBD

E-mail:

**Class Schedule**

Lectures: Tuesdays and Thursdays, 2:35 pm – 3:55 pm, Southam Hall 501.

Instructor's office hours: Tuesdays and Thursdays, 4:00pm – 5:00pm, HP5348.

TA's office hours: TBD.

Notes and references in cuLearn: <https://culearn.carleton.ca/moodle/course/view.php?id=141542>

**Course Description**

The course covers the use of game engines for the development of computer games, and advanced techniques relevant to games, such as 3D rendering, animation, and the simulation of physics.

**Topics Covered**

- Architecture of games and game engines.
- Advanced rendering techniques: deferred rendering, global illumination heuristics, illumination models, programming of surface, vertex, and fragment shaders
- Animation: key-frame animation, mesh animation, character animation, locomotion.
- Rigid-body physics: collision detection, animation based on physical simulation.
- Introduction to soft-body physics.
- Shape modeling and acquisition.
- Networking, AI, pathfinding.

**Learning outcomes**

At the end of this course, students will be able to:

- Design the software architecture for a game of reasonable complexity, using a component-based architecture model.
- Summarize the main components that typically compose a game engine, explaining how these are integrated into a coherent software architecture, and how they can be used for game development.

- Explain the principles behind common techniques used for the creation of games, such as rendering, animation, and physical simulation. This includes the mathematical concepts and algorithms related to these techniques.
- Identify the most suitable techniques that can be used to add a specific functionality or effect to a computer game.
- Implement a game of reasonable complexity in the Unity engine, using 3D graphics.

## Resources

We do not have an assigned textbook, as the course draws topics from a variety of areas. The following books are useful for the main topics discussed in the course:

- **Game engines:** Jason Gregory, "Game Engine Architecture", Second Edition, CRC Press, 2015.
- **Computer graphics:** Peter Shirley, Steve Marschner, "Fundamentals of Computer Graphics", Third Edition, CRC Press, 2009.
- **Real-time rendering, physically-based rendering:** Tomas Akenine-Möller, Eric Haines, and Naty Hoffman, "Real-time rendering", Third Edition, A. K. Peters, 2008.
- **Animation:** Rick Parent, "Computer Animation: Algorithms and Techniques", Third Edition, Morgan Kaufmann, 2012.

The programming assignments and course project will be based on the Unity Engine (<https://unity3d.com/>). There is a wealth of books and on-line tutorials specific to programming in Unity. I would advise to start by checking the tutorials provided in the Unity website.

You are free to make use of material found online provided you credit the source. In particular, models and images found online are fair game. Code fragments you take from an online source are allowed but do give credit and make sure you understand what the code is doing.

## Evaluation

Grading scheme:

Assignments + course project: 60%

Final (take home) exam: 40%

Note that you need to obtain a passing grade on the final exam to pass the course.

## Late assignments policy

Assignment deadlines are strict. The following scheme is applied to late submissions (which includes assignments and the milestones of the course project):

- 3 hours late: no penalty
- 3 to 12 hours late: -10%
- 12 to 24 hours late: -20%
- More than one day late: assignment receives a grade of zero

### **CS Undergraduate Academic Advisor**

The undergraduate advisor for the School of Computer Science is available in Room 5302C HP, by telephone at 520-2600, ext. 4364 or by email at [undergraduate\\_advisor@scs.carleton.ca](mailto:undergraduate_advisor@scs.carleton.ca). The advisor can assist with information about prerequisites and preclusions, course substitutions/equivalencies, understanding your academic audit and the remaining requirements for graduation. The undergraduate advisor will also refer students to appropriate resources such as the Science Student Success Centre, Learning Support Services and the Writing Tutorial Services.

### **Centre for Student Academic Support (CSAS)**

The Centre for Student Academic Support (CSAS) is a centralized collection of learning support services designed to help students achieve their goals and improve their learning both inside and outside the classroom. CSAS offers academic assistance with course content, academic writing and skills development. Visit CSAS on the 4th floor of MacOdrum Library or online at: [carleton.ca/csas](http://carleton.ca/csas).

### **University Policies**

#### **Student Academic Integrity Policy**

Every student should be familiar with the Carleton University student academic integrity policy. A student found in violation of academic integrity standards may be awarded penalties which range from a reprimand to receiving a grade of F in the course or even being expelled from the program or University. Some examples of offences are: plagiarism and unauthorized co-operation or collaboration. Information on this policy may be found in the Undergraduate Calendar.

#### **Plagiarism**

As defined by Senate, "plagiarism is presenting, whether intentional or not, the ideas, expression of ideas or work of others as one's own". Such reported offences will be reviewed by the office of the Dean of Science.

#### **Unauthorized Co-operation or Collaboration**

Senate policy states that "to ensure fairness and equity in assessment of term work, students shall not co-operate or collaborate in the completion of an academic assignment, in whole or in part, when the instructor has indicated that the assignment is to be completed on an individual basis". Please refer to the course outline statement or the instructor concerning this issue.

#### **Requests for Academic Accommodation**

You may need special arrangements to meet your academic obligations during the term. For an accommodation request, the processes are as follows:

**Pregnancy obligation**

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website: [carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

**Religious obligation**

Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, visit the Equity Services website: [carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf)

**Academic Accommodations for Students with Disabilities**

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. [carleton.ca/pmc](https://carleton.ca/pmc)

**Survivors of Sexual Violence**

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and its survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: [carleton.ca/sexual-violence-support](https://carleton.ca/sexual-violence-support)

**Accommodation for Student Activities**

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. <https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf>

For more information on academic accommodation, please contact the departmental administrator or visit: [students.carleton.ca/course-outline](https://students.carleton.ca/course-outline)

Preliminary course outline subject to change; last updated on Wed Oct 30 2019.