

Carleton University, Computer Science, Winter 2021

Comp 2501 (with Tutorial) Computer Game Design and Development

Class Times/Instructor: Wed/Fri 6-7:30 via Zoom, via Zoom, **W.R. Lalonde**

Contact: wilf.lalonde@gmail.com

Workshop (Preallocated slots, extra slot thurs): Mon 11:30-1pm, Thurs 6-7:30, Fri 1-2:30 via Zoom

No classes: Winter break week of Feb 14-20, Frid April 2.

Last day of classes: April 14 for slightly over 12 weeks of classes

Course Description: C++ Programming and math skills needed for developing 3D games. Classes needed to implement players, cameras, models, shaders, and sprites. Math needed for understanding position, directions, normals, and headings. Matrices for transformations and their inverses in both left-handed and right handed systems. Their uses in controlling objects, cameras, and texture manipulation. Facilities to support collision detection. Includes subsets of new first year course **Comp 1008 Math for Game Programmers**.

Prerequisite: Math 1104, COMP 1501, comp 2401.

Course Goals: The course has 2 goals: (a) to teach the 3D gaming math you will need in all subsequent courses and (b) to develop your C++ skill assuming you have taken or are currently taking a C++ course.

Course Work: Last year's version of this course had 6 assignments, 1 project, 1 test and 1 exam for 9 submissions. Because of this year's special circumstances, we will instead have roughly 1 assignment per week marked A/B/C (100%, 70%, 50%) with NO test and NO exams and with SIMPLER assignments. The emphasis is NOT on marks but on making sure that you develop your skills. So it is very important that **YOU** do the assignments and **NOT LET A FRIEND** do it for you.

Book (not required) But useful if you wish to develop your own useful library. Available from amazon.ca. **OpenGL ES 3.0 Programming Guide, Second edition, Dan Ginsburg and Budirijanto Purnomo.**

Reference Book: Mathematics for 3D Game Programming & Computer Graphics (Third edition is the latest), Eric Lengyel, Charles River Media, Inc. This will be the book used by **Comp 1008 Math for Game Programmers**

Handing in: Via <https://carleton.ca/culearn/> but **all download materials will be available from**

Web: <http://www.scs.carleton.ca/~lalonde> (my page), and
<http://www.scs.carleton.ca/~lalonde/comp2501> (course page).

Course Outline

The rendering pipeline

Generic overview

Left versus right-handed systems

Left-to-right versus right-to-left evaluation math

Coordinates spaces (object, world, camera, and perspective)

Tuples

The distinction between points, vectors, normal

Two definitions of vector dot products

Two definitions of vector cross product

Intuitions behind dot products and cross products

Many operations and related theorems on tuples, points, vectors, dot products and cross products.

Matrices

Matrix multiply plus many other operations

Matrix inverses and how to compute them

Useful theorems involving transposes and inverses

Matrix forms of dot and cross products

Transformations

Translating, rotating, scaling transformations and their inverses

Projection transformations

Properties of rotations

The general rotation transformation

Fast inverses

Transformations for gaming

Controlling placement

Object placement in worlds

Texture placement in objects

Camera placement in worlds

Controlling and animating changes

Changes relative to an Object (pre-transformations)

Changes relative to a World (post-transformations)

Changes relative to a Parent

Controlling changes when dealing with inverses

Changes from right to left-handed systems

Articulated figures, poses, and skinning

Object and camera “look at” functions

Visibility determination

Bounding boxes, planes, frustum, and visibility trees

Octrees, quad trees, bounding box trees, and bsp trees.

Distance to planes, plane transformations

Building frustum, frustum transformations

Determining if points, bounding boxes, and spheres are inside frustums

Sprites and how to draw them without needing to rotate them

Portal visibility

Collision detection and collision reacting

Movement boxes and collision detection trees (similar to visibility trees)

Basic algorithms for projections of points on a line, on a plane

Basic algorithm for intersection of a line with a plane, with a sphere

The concept of object sweeping.

Point sweeps colliding with planes, spheres, bounding boxes, polygons, and polygon soup.

Sphere sweeps colliding with planes, spheres, bounding boxes, polygons, and polygon soup.

More general sweeps done efficiently

Quaternions

Definitions and how they are used for rotations.

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. The undergraduate 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 Writing Tutorial Services.

SCS Computer Laboratory

SCS students can access one of the designated labs for your course. The lab schedule can be found at: <https://carleton.ca/scs/tech-support/computer-laboratories/>. All SCS computer lab and technical support information can be found at: <https://carleton.ca/scs/technical-support/>. Technical support is available in room HP5161 Monday to Friday from 9:00 until 17:00 or by emailing support@scs.carleton.ca.

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.

Academic Accommodations for Students with Disabilities

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and 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 me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable) at <http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines>

Religious Obligation

Write to me 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: <http://www2.carleton.ca/equity/>

Pregnancy Obligation

Write to me 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: <http://www2.carleton.ca/equity/>

Medical Certificate

The following is a link to the official medical certificate accepted by Carleton University for the deferral of final examinations or assignments in undergraduate courses. To access the form, please go to <http://www.carleton.ca/registrar/forms>