Course Description  This course introduces material on the mathematics, algorithms, and techniques for the creation, manipulation, representation, and display of geometric objects. We will discuss the modeling and design of curves, surfaces, and solids. Applications include computer animation, visualization, computer-aided design and engineering systems (such as those used for aircraft, vehicle, and ship design), and the reconstruction of continuous geometry from discrete points.

Students will learn both the theoretical aspects and practical tradeoffs of different geometric modeling techniques. By utilizing computer graphics libraries, students will also implement components of an interactive system for modeling curves and surfaces.

Prerequisites  CPSC 605 or consent of instructor.

Course Objectives  This course will cover both classical geometric modeling topics as well as its modern use in computer graphics. It is designed to prepare students to:

- learn the modeling of curves using Bezier and B-spline approximations;
- extend these definitions to surfaces;
- understand both rational polynomial curves and NURBs;
- learn surface subdivision and reconstruction techniques;
- work with unstructured, polygonal representations of geometry;
- master object construction and manipulation, including its applications to CAD systems; and
- conduct research in advanced computer graphics topics in geometry, including mesh generation, shape analysis, parameterization, differential geometry, computational topology, and others.

Students will read, discuss, and present relevant texts and research papers, as well as be evaluated using a series of programming projects involving computer graphics and computational geometry libraries.

Required Text and Handout Materials
- Many other handout materials linked to on the course schedule page.

Additional Reference Reading Material
Content

Course Outline

I. Fundamentals, Interpolation, and Curve Modeling
   - Introduction
   - Bezier Curves
   - Lagrange and Hermite Interpolation
   - Subdivision curves
   - B-splines
   - Matrix Forms
   - Rational Polynomial Curves
   - NURBs

II. Surface Modeling, Subdivision, and Volumes
   - Surface topology
   - Curvature
   - Bezier Surfaces
   - B-spline Surfaces
   - B-spline Subdivision Schemes
   - Doo-Sabin and Catmull-Clark Subdivision
   - Triangulation and Loop Subdivision
   - Surface Interrogation
   - B-rep and Boolean Ops
   - Elements of CAD: Extrusion, Rotation, Lofting, Sweeping
   - CSG Representations and Euler Ops.

III. Applications and Advanced Research Topics
   - Voronoi Diagrams and Delaunay Triangulations
   - Curve and Surface Reconstruction
   - Registration
   - Simplification and Decimation
   - Smoothing
   - Discrete Differential Geometry
   - Parameterization
   - Remeshing
   - Shape Analysis
   - Deformation
   - Segmentation
   - Spectral Methods

IV. Software Tools for Geometric Modeling
Grading  Grades will be assigned based on the following scale:
• A ≥ 90%
• B ≥ 80%
• C ≥ 70%
• F < 70%
Grading will be based on performance on the set of programming projects, the class final project, paper presentations, and class participation, using the following percentage distribution:
• Programming Labs: 50%
• Final Project: 25%
• Paper Presentations: 15%
• Class Participation: 10%
Submission for labs, final project, reviews, and design critiques will be due on midnight of the due date, a late submission will receive a penalty of 10% per day for each work day it is late.

Programming Labs  Students will be asked to complete programming projects involving geometric modeling topics. These will typically involve programming in C++ and/or OpenGL. Throughout the semester we will have 5 programming projects. Demoing your projects to me is required.

Final Project  A final project of the student’s choice may be completed using any of the skills learned in the class. Projects will be proposed midway through the semester and must demonstrate knowledge in a subarea related to the course.

Paper Presentations  As one of the major goals of this course is to prepare students to be able to read research papers in the field of geometric modeling, one of the main exercises we will do is reading and presenting papers relevant to the material discussed in class. One third of each lecture will be devoted to a research paper relevant to the material of the course. Throughout the semester each student will present at least 2 research papers, the instructor will present for the remaining slots.

Class Participation  The class participation grade is the instructor’s subjective judgement of the student’s contribution to a lively classroom atmosphere. He will consider mainly active, informed participation in classroom discussions. Obviously, students not attending class are not contributing in this way.

One component of the participation grade will be evaluating the presentations of each other student. Positive feedback and constructive criticism will be provided to the student(s) who completed that week’s critique.
Policies

Late Instructor  Your instructor will make every effort to be in class on time, or to inform you of any delay or cancellation. In the unusual event that he should not arrive in class or send word by 15 minutes from the class start time, the class is officially cancelled.

Attendance  Optional, but remember that a percentage of the grade is based on class participation.

Collaboration Yes, Plagiarism No  In this course, we want to encourage collaboration and the free interchange of ideas among students and in particular the discussion of homework and quiz problems, approaches to solving them, etc. However, we do not allow plagiarism, which, as commonly defined, consists of passing off as one’s own ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

Copyright  Materials in this course are copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Students should refer to the Use of Copyrighted Materials and Fair Use Guidelines policy on the Clemson University website for additional information: http://www.lib.clemson.edu/copyright/.

Disability Access  It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Student Disability Services, Suite 239 in the Academic Success Center, 656-6848, to discuss their individual needs for accommodation. Accommodations are individualized, flexible, and confidential and are based on the nature of the disability and the academic environment, in compliance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. Details on policies and procedures are available at http://www.clemson.edu/sds/.

Academic Integrity  As members of the Clemson University community, we have inherited Thomas Green Clemson’s vision of this institution as a “high seminary of learning.” Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity.

Refer to the graduate academic integrity policy at http://gradspace.editme.com/AcademicGrievancePolicyandProcedures#integritypolicy. Each graduate student should read this policy annually to be apprised of this critical information.