MAT 500 Syllabus

Semester:	Summer 2017
Course title:	Curves and Surfaces
Instructor:	Professor Matt Klassen
Email:	mklassen@digipen.edu
Phone:	(425) 895-4423
Office hours:	M,W 2:00-3:30 or by appointment
Course Web Page:	http://azrael.digipen.edu/MAT300
Time/Place:	M,W 4:00-5:40, Hokusai

WEB PAGES AND MOODLE:

The Moodle page for MAT500 will contain a link to the course web page. The web page is the central repository for all course documents, including homework assignments. Updates to homework will be posted on the web page only. Scores for quizzes, homework, exams, and projects, will be posted through perl scripts on the course web page.

The Moodle page will be primarily used for chat, forums, and for submission of projects.

MATERIALS:

Text: None. The course is based on lecture material, notes, and homework.

Reference Materials (not required) :

Bezier and B-Spline Techniques, by Prautzsch, Boehm, and Paluszny
Geometric Modeling with Splines, by Cohen, Riesendfeld, and Elber
Curves and Surfaces in Geometric Modeling, by Jean Gallier
A Practical Guide to Splines, by Carl de Boor
An Introduction to Splines for Use in Geometric Modeling, by Bartels, Beatty, and Barsky
Geometry and Interpolation of Curves and Surfaces, McLeod and Baart

BACKGROUND MATHEMATICS:

Calculus and Linear Algebra.

COURSE CONTENT:

The subjects of geometric modeling and mathematical computer graphics are heavily dependent on linear algebra. In this course we look at this dependence in detail, showing how many of the main objects and algorithms in this field come from specific basis representations of certain vector spaces of functions.

This course focuses on properties of polynomial and piecewise polynomial, or spline, curves. We begin with polynomials in one variable. Vector space properties of the polynomial and spline functions are emphasized. For example, the special bases known as Bernstein polynomials and B-spline functions are studied. When used in the evaluation of curves these two cases are known as the De Casteljau and De Boor algorithms. Interpolation and Approximation properties of these functions are also discussed. For polynomials we use the Lagrange and Newton forms and study the divided differences. We focus on Bezier and B-spline curves. A basic introduction to surfaces, including tensor product surfaces is presented at the end.

COURSE GOALS AND OBJECTIVES:

1) Students will learn two basic algorithms in geometric modeling: The De Casteljau and De Boor algorithms. They will demonstrate their understanding through a programming project and also through various homework and quizzes.

2) Students will become familiar with basic concepts of geometry relating to parametric curves and surfaces.

3) Students will solidify their knowledge of Linear Algebra by using it as a tool to solve problems involving vector spaces of polynomial and spline functions.

QUIZZES AND EXAMS:

Quizzes will be given periodically to test comprehension of lecture material. There are no make up quizzes, but I do drop your lowest two quiz scores. The quizzes will last for approximately twenty minutes.

For multiplie choice quizzes and exams, please follow these procedures: Work out the quiz problems and circle your answers on the question sheet. When you are finished, transfer the answers to the answer sheet. Go to a web browser and enter the answers online. Under no circumstances are you allowed to discuss the quiz questions with any other student during the quiz or the data entry process. You should turn in the answer sheet at the front of the room, and keep the question sheet for reference. Your scores will be posted online by your student ID.

There will be a midterm exam given during regular class hours, and a final exam. There are *NO* make up exams unless you have a *compelling and well documented reason* for missing a test.

Calculators are allowed on quizzes and exams.

GRADING:

Midterm Exam	20%
Final Exam	20%
Homework	20%
Quiz	20%
Projects	20%

Grades will be determined based on total course percentage. Percentage scores will determine letter grades according to the scale: (in the worst case)

A	93 – 100	A-	90 – 92.9		
B+	87 – 89.9	B	83 – 86.9	B-	80 – 82.9
C+	77 – 79.9	C	73 – 76.9	C-	70 – 72.9
D	60 – 69.9	F	< 60		

ACADEMIC INTEGRITY:

Academic dishonesty, or cheating, occurs when a student represents someone else's work as their own, or assists another student in doing so. This can happen on exams, quizzes, homework, or projects. Academic dishonesty also may occur when a student uses any prohibited reference or equipment in the completion of a task. For example, the use of a calculator, notes, books or the internet when it is prohibited. Plagiarism is a common form of academic dishonesty. This can take the form of copying and pasting exerpts from the web, and representing them as original work. The type and severity of any occurence, as well as the legitimacy of any claim of academic dishonesty, will be judged by the instructor and the disciplinary committee. All students are asked to help in promoting a culture of academic integrity by discouraging cheating in all forms.

HOMEWORK ASSIGNMENTS:

Homework will be assigned and posted on the web page and collected weekly. You are responsible for checking the web page and noting the assignments and the due date. You may work on homework together, as well as consult the tutors and the instructor. However, the final work that you turn in must be your own work.

PROJECTS:

The full description of the programming project can be found on the course web page. Submission of projects should be in a zipped folder which contains source and executable and which can be uploaded on the Moodle page.

The programming project is in eight parts, each worth equal weights. Grade is based on best 4 of the eight parts. Additionally, projects done beyond the required 4 of 8 can be counted as extra credit quizzes. Tentative due dates are listed below (subject to change on Moodle).

1. I De Casteljau Algorithm for Polynomial Functions – due Friday 5/26,
2. II De Casteljau Algorithm for Bezier Curves – due Friday 6/2,
3. III Interpolation with Polynomials – due Friday 6/9,
4. IV Interpolation with Cubic Splines – due Friday 6/16,
5. V De Boor Algorithm: Spline Functions – due Friday 6/30,
6. VI De Boor Algorithm: Polynomial Curves – due Friday 7/7,
7. VII De Boor Algorithm: B-Spline Curves – due Friday 7/14
8. VIII 3D Curves: Implement one of previous projects in 3D – due Friday , 7/21

COMPUTATIONAL RESOURCES:

You are encouraged to do linear algebra and other calculations for the homework using a calculator or symbolic package such as PARI. The symbolic algebra package PARI/GP is free and open-source. There is a link on the web page with examples of how to use PARI to do basic linear algebra calculations. Another package which includes PARI is called SAGE (Software for Algebra and Geometry Experimentation.)

GRADUATE STUDENTS:

Graduate students will be required to do a class presentation or report which will be factored in as part of their homework grade. The subject matter will involve an in depth analysis of a particular problem, or an application, and will require some synthesis of current work and contributions in the field. This will form part of the graduate student exposure to research methods in course work.

DISABLED STUDENT SERVICES:

Students with physical, psychological or learning disabilities that affect their ability to perform major life activities associated with this class may be eligible for reasonable accommodations under the Americans with Disabilities Act. If you have a documented disability please contact the Disability Support Services office to arrange for accommodations for this class.

TENTATIVE WEEKLY TOPICS:

Week	Dates	Topics
1	May 15, 17	Project I overview (Bernstein Polynomials, control coefficients/points); Project II overview (Nested Linear Interpolation, BB-form, Midpoint Subdivision); Linear Algebra Review; Polynomial Vector Spaces, Bases: standard, shifted, Vandermonde, Top-down, and Bernstein.
2	May 22, 24	Special properties of Bernstein polynomials (Basis, Partition of Unity, Recursion, Symmetry, Positivity, Derivatives); Change of basis for polynomials;
3	May 31	Polynomial Interpolation (Standard basis form, Lagrange form, and Newton form); Project III overview (interpolation)
4	June 5, 7	Divided differences (dd), derivations of the Newton form, definition of B-splines with dd, Leibniz Rule for dd; Interpolation with Derivatives (Osculation); Project IV overview (cubic spline interpolation).
5	June 12, June 14	Polar forms for polynomials. Bezier Curves: BB-form, derivatives, implicit forms (parabolas, tangent construction);
6	June 19, 21	Project V overview (DeBoor algorithm for spline functions). Wednesday: Midterm Exam (Polynomials through Bezier Curves);
7	June 26, 28	Piecewise polynomials and spline functions; standard basis for splines; Overview of spline projects VI, VII.
8	July 3, 5	Proofs for polar forms and connections to splines; Knot sequences for spline bases
9	July 10, 12	Change of basis for splines; Overview of B-splines with graphs and properties
10	July 17, 19	B-splines with divided differences and Recursion; Special properties of B-splines.
11	July 24, 26	Cramers Rule and B-splines with determinants; Curry-Schoenberg Theorem on B-spline bases. Schoenberg-Whitney Theorem and interpolation with B-splines;
12	July 31 - Aug 4	Final Exams