MAT 500 Syllabus

Semester:	Spring 2021
Course title:	Curves and Surfaces
Instructor:	Professor Matt Klassen
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Phone:	(425) 895-4423
Office hours:	T,W 2:00-3:00, or by appointment
Course Web Page:	http://azrael.digipen.edu/MAT300
Time/Place:	T,Th 11:00-12:20, online in Teams

WEB PAGES, TEAMS AND MOODLE:

The Moodle page for MAT300 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.

The Teams channel will be used for lectures. Students may record lectures and review them in Teams.

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 DESCRIPTION:

This course is an introduction to parameterized polynomial curves and surfaces with a view toward applications in computer graphics. It discusses both the algebraic and constructive aspects of these topics. Algebraic aspects include vector spaces of functions, special polynomial and piecewise polynomial bases, polynomial interpolation, and polar forms. Constructive aspects include the de Casteljau algorithm and the de Boor algorithm. Other topics may include an introduction to parametric surfaces and multivariate splines.

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. For exam you will also be required to turn in your scratch work on Moodle, which may be used to show that you did your own work. 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		

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.

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 1/22,
2. II De Casteljau Algorithm for Bezier Curves – due Friday 2/5,
3. III Interpolation with Polynomials – due Friday 2/26,
4. IV Interpolation with Cubic Splines – due Friday 3/12,
5. V De Boor Algorithm: Spline Functions – due Friday 3/26,
6. VI De Boor Algorithm: Polynomial Curves – due Friday 4/2,
7. VII De Boor Algorithm: B-Spline Curves – due Friday 4/9
8. VIII 3D Curves: Implement one of previous projects in 3D – due Friday 4/16

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.)

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	Jan 4 - 8	Pynomials, control coefficients); Linear Algebra Review; Polynomial Vector Spaces, Bases: standard, shifted, Vandermonde, Top-down, and Bernstein.
2	Jan 11 - 15	Calculus of parametric curves, TNB frame. Special properties of Bernstein polynomials (Basis, Partition of Unity, Recursion, Symmetry, Positivity, Derivatives); Change of basis for polynomials;
3	Jan 18 - 22	Project II overview (Nested Linear Interpolation, BB-form, Midpoint Subdivision); Polynomial Interpolation (Standard basis form, Lagrange form, and Newton form);
4	Jan 25 - 29	Divided differences (dd), derivations of the Newton form, definition of B-splines with dd, Leibniz Rule for dd.
5	Feb 1 - 5	Project III overview (interpolation) Interpolation with Derivatives (Osculation); Polar forms for polynomials.
6	Feb 8 - 12	Bezier Curves: BB-form, derivatives, implicit forms (parabolas, tangent construction); Polar forms for polynomials and curves. Project IV overview (cubic spline interpolation);
7	Feb 15 - 19	Project IV overview (cubic spline interpolation) Thursday, Feb.18: Midterm Exam (Polynomials through Bezier Curves);
8	Feb 22 - 26	Project V overview (spline functions with de Boor algorithm); proofs for polar forms; Piecewise polynomials and spline functions; standard basis for splines;
	Mar 1 - 5	Spring Break
9	Mar 8 - 12	Overview of spline project VI (polynomial curves with de Boor algorithm); Knot sequences for spline bases;
10	Mar 15 - 19	Overview of spline project VII (spline curves with de Boor algorithm); Change of basis for splines; Overview of B-splines with graphs and properties
11	Mar 22 - 26	B-splines with divided differences and Recursion; Special properties of B-splines.
12	Mar 29 - Apr 2	Overview of project VIII (3D curves); Cramers Rule and B-splines with determinants; Curry-Schoenberg Theorem on B-spline bases.
13	Apr 5 - 9	Schoenberg-Whitney Theorem and interpolation with B-splines;
14	Apr 12 - 16	Introduction to 3D curves and surfaces.
15	Apr 19 - 23	Final Exams