CMSC 838M – Physically-based Modeling, Simulation and Animation

Spring 2025

Meeting Place: CSIC 2117
Meeting Time: Tues/Thur 2:00pm - 3:15pm

Instructor: Ming C. Lin
Telephone: 301-405-2662
Office: IRB-5162
E-mail: lin@cs.umd.edu
Office Hours: Tues/Thur After Class or By Appointment

Text: SIGGRAPH course notes and in-class handouts.

Prerequisites: CMSC 330, CMSC 351 AND Scientific Computing *OR* Instructor's approval

Course Description: This is an advanced graduate course on physically-based modeling, simulation and animation. In this course, we will study various techniques to simulate the physical and mechanical behavior of objects in a graphical simulation or a virtual environment. Students will learn about implementation of basic simulation programs that produce interesting results and verify its correctness. The course will cover three basic components in physically-based modeling and simulation: (a) geometry, (b) mechanics, (c) numerical computing.
The goal of this class is to get students an appreciation of computational methods for modeling of motions in the physical and virtual world. We will discuss various considerations and tradeoffs used in designing simulation methodologies (e.g. time, space, robustness, and generality). This will include data structures, algorithms, computational methods and simulation techniques, their complexity and implementation. The lectures will also cover some applications of physically-based modeling and simulation. Upon successful completion of the course, you should:

1. Be aware with a collection of geometric algorithms for modeling contacts.
2. Be knowledgeable with the following numerical methods for simulation: initial value problems, constrained optimization, differential-algebraic equations, boundary value problems, etc.
3. Be familiar with the following modeling paradigms of physical and biological systems: particle dynamics, rigid body dynamics, flexible and deformable bodies
4. Be able to analyze the correctness and runtime performance of a given simulation method.
5. Be able to apply some of these techniques to research problems. in real-world problems.

Grading:	Oral Presentation/Exam	20%
	Labs & Homework	30%
	Final Project/Exam	50%

Letter grades will not be assigned on the curve, but on absolute standards. Your final grade in this course will be determined solely by how much you learn. In-class participation will be taken into account in the case of "borderline" performance between two grades.

Homework: Homework assignments are due *at the beginning of each class* on the due date given. *No late homeworks will be accepted.* There will be 3 homework assignments. Some of the homework assignments will require some programming efforts. You are encouraged to discuss the problem sets in group, but when it comes to formulating/writing solutions you must work alone independently. Copying homework solutions from another student will be considered cheating. Instances of academic dishonesty will be dealt with harshly.
As a courtesy to the instructor, homework should be written neatly. Poorly written homework sets will not be graded. When writing algorithms be sure not only that your solution is correct, but also that it is easy for the grader to understand why your solution is correct. Part of your grade will be based not only on correctness, but also on the clarity, simplicity, and elegance of your solution.

In-Class Presentation: Each student is expected to lead a lecture of his/her choice of topics, with the instructor's apporval. All students are required to meet the instructor on one-to-one basis to discuss the lecture materials in detail prior to the presentation. One week before the scheduled presentation, s/he will be expected to submit a draft version of the presentation materials and an initial treatment of the selected topics. The instructor will provide timely feedback about the pre-talk. Reading materials and/or discussion issues will be posted on the course web site, at least one day prior to each lecture. All class members will be expected to have read the listed readings, by the start of the relevant class.

Final Projectl: Each student (possibly with a partner) is expected to propose and complete a final project, likely with substantial programming efforts related to physically-based modeling, simulation and animation. Many topics will be suggested, but students are free to select their own project topic.

Communication: The instructor's office hours will be as posted, or by appointment and email correspondence. A class mailing list will be set up to broadcast important messages related to the class. Please send mail to lin@cs.unc.edu to add yourself to the mailing list.
Lecture notes, homework problems sets, handouts and class announcements will also be posted on the course home some page at the following URL:

`http://www.cs.umd.edu/class/spring2025/cmsc838M/`

Make-up Course Work: In exceptional circumstances (serious illness, university business, a death in the family), an extension or a make-up exam may be granted. (The problems of student life, including the consequences of procrastination and commitments to other courses are not regarded as "exceptional circumstances".) However, all extensions or alternative arrangements must be approved by the instructor BEFORE the due date. In circumstances that merit special consideration, documentation is usually available to the student, and the instructor feels most comfortable when a request for make-up work is accompanied by appropriate written material supporting such a request.