CSci 6974 and ECSE 6966
Mathematical Techniques for Computer Vision, Graphics and Robotics
Spring Semester, 2006
Course Syllabus

Prof. Chuck Stewart
Mon, Thurs 12:00 - 1:20, Low 4034
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Hours: After class, Tue 1-3
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The goal of this course is to provide an introduction to some of the mathematical background needed to do research in computer vision, computer graphics and robotics. At the end of this course students should be able to work through the mathematical details in many of the papers in these three fields. Unfortunately, the coverage will be neither sufficiently broad or sufficiently deep to ensure familiarity with all techniques encountered in the research literature. Therefore, a second goal of the course is to provide students with sufficient background to explore new mathematical methods on their own. Fortunately, the web now contains a wealth of resources to assist in this.

Course requirements are straightforward. There will be weekly homework assignments and three exams. The exams correspond to the 3 major sections of the course. The homework will be worth 25% of the semester grade and the exams will each be worth 25%. The homework will include problems to be turned in and additional problems for self-study. Many of the questions on the exams will be drawn from these additional problems. The tentative dates for the exams are February 23, April 6, and May 1, but these may be shifted as our schedule warrants.

Students may work together on homework problems and use additional textbook and web resources as well. Solutions are to be written independently, however, and sources for solutions — whether it be the result of a group effort or found in a book, journal or website — should be properly sited. Some homework problems may be designated to be done independently. Tests will be in-class and will be closed-book and closed-notes. Some formulas may be provided with the tests.

The course is broken into 3 main topic area: linear algebra, geometry, and estimation:

- The linear algebra section will start with the basics of vectors and matrices, and continue to vector spaces, matrix decompositions, bases, eigenvalues and eigenvectors. It will end with a discussion of several applications.

- The geometry section will cover properties of Euclidean, affine, and projective geometries, as well as providing an introduction to differential geometry. It will include an introduction to the geometry of the perspective camera.

- The estimation and optimization section will cover a variety of topics. It will start some background on statistics, and then cover regression, contrained optimization, robust estimation, non-linear estimation, and linear programming.

Although there is no text book for this course, much of the material is drawn from two sources:

- Gilbert Strang, *Linear Algebra and Its Applications*, 3rd Edition, Brooks/Cole, 1988.

- Richard Hartley and Andrew Zisserman, *Multiview Geometry*, 2nd Edition, Cambridge University Press, 2004.