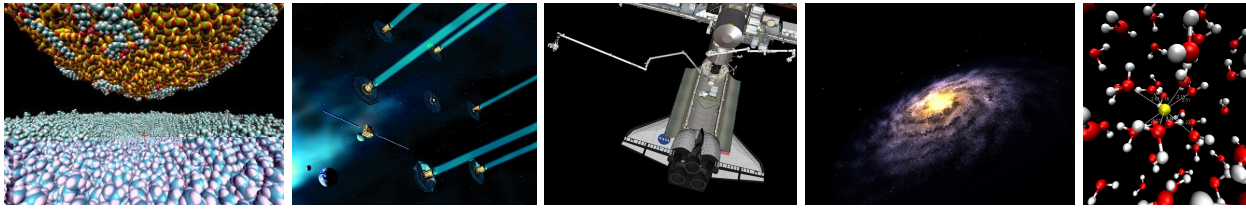


MATH 273A: Geometric Numerical Integration

MWF 11:00am–11:50am, APM 2402

<http://www.math.ucsd.edu/~mleok/courses/ma273a.html>



INSTRUCTOR	Prof. Melvin Leok, Department of Mathematics Office: APM 5763, phone: (858)534-2126, email: mleok@math.ucsd.edu http://www.math.ucsd.edu/~mleok/
TARGET AUDIENCE	This course is relevant to engineers, scientists, and mathematicians with an interest in long-time simulations of mechanical systems, including applications to robotic motion planning, astrodynamics, rigid-body, molecular and stellar dynamics. The application areas addressed will be tailored to the interests of the course participants.
COURSE DESCRIPTION	<p>Many differential equations of interest in the physical sciences and engineering exhibit geometric properties that are preserved by the dynamics. Recently, there has been a trend towards the construction of numerical schemes that preserve as many of these geometric invariants as possible.</p> <p>Such methods are of particular interest when simulating mechanical systems that arise from Lagrangian or Hamiltonian mechanics, wherein the preservation of physical invariants such as the energy, momentum, and symplectic form can be important when simulating long-time dynamics of such systems.</p> <p>In applications arising from astrodynamics and robotics, the dynamics evolve on nonlinear manifolds such as Lie groups, and in particular the rotation group, and the special Euclidean group. Numerical schemes that respect the underlying nonlinear manifold structure will also be discussed.</p> <p>This course will begin with an overview of classical numerical integration schemes, and their analysis, followed by a more in depth discussion of the various geometric properties that are of importance in many practical applications, followed by a survey of the various geometric integration schemes that have been developed in recent years. Issues pertaining to the analysis and implementation of such schemes will also be addressed.</p>
BACKGROUND	A strong undergraduate background in linear algebra, and differential equations; Some familiarity with numerical methods, classical mechanics and differential geometry would be helpful, but not essential; Programming experience in any language, e.g., C/C++, FORTRAN, MATLAB.
TEXTBOOK	Simulating Hamiltonian Dynamics Cambridge Monographs on Applied and Computational Mathematics, Leimkuhler, Reich, Cambridge University Press, 2005. ISBN: 0521772907
COURSE TOPICS	Numerical methods, Hamiltonian mechanics, Geometric integrators, Modified equations, Higher-order methods, Constrained mechanical systems, Rigid body dynamics, Adaptive geometric integrators, Highly oscillatory problems, Molecular dynamics, Hamiltonian PDEs.
GRADING	Your grade in the course is based on your project and your 20-minute project presentation during the time of the final. The topic of your project should be decided in consultation with the instructor before the end of the first month of class.