TAM 674
Applied Multibody Dynamics
A How-To Course

Spring Term 2003, Mon & Wed 10:10-11:00, 202 Thurston Hall, 3 credits

instructor:
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Introduction
In this course we will cover a systematic approach to the generation and solution of equations of motion for mechanical systems consisting of multiple interconnected rigid bodies, the so-called multibody systems. This course differs from “advanced dynamics”, which mostly covers theoretical results about classes of idealized systems (e.g. Hamiltonian systems), in that the goal here is to find the motions of relatively realistic models of systems (including, for example, motors, dissipation and contact constraints).

By the end of the course you will be competent at finding the motions of linked rigid body systems in two and three dimensions including systems with various kinematic constraints (sliding, hinges and rolling, closed kinematic chains). Collisonal interactions will be considered in a unified manner for all the different ways of formulating the equations of motion.

There will be weekly homework assignments and a final project. In doing the homework I encourage you to work together and to use computer software like MATLAB, MAPLE, ADAMS, WORKING MODEL etc.

Course topics
- Newton-Euler equations of motion for a simple planar system, free body diagrams, constraint equations and constraint forces, uniqueness of the solution.
- Systematic approach for a system of interconnected rigid bodies, virtual power method and Lagrangian multipliers.
- Transformation of the equations of motion in terms of generalized independent coordinates, and Lagrange equations.
- Non-holonomic constraints as in rolling without slipping, degrees of freedom and kinematic coordinates.
- Unilateral constraints as in contact problems.
- Numerical integration of the equations of motion, stability and accuracy of the applied methods.
- Numerical integration of a coupled differential and algebraic system of equations (DAE’s), Baumgarte stabilisation, projection method and independent coordinates.
- Newton-Euler equations of motion for a rigid three-dimensional body, the need to describe orientation in space, Euler angles, Cardan angles, Euler parameters and Quaternions.
- Equations of motion for flexible multibody systems, introduction to Finite Element Method approach, Linearised equations of motion.

Upon request and if time and ability of the instructor allows, related topics are open for discussion.
Literature
There are no lecture notes for this course. On the other hand there is a vast amount of literature in the field of Multibody System Dynamics. Most books can be found in the library.

Dynamics, general

Linear Algebra

Multibody System Dynamics

Web Site
http://www.tam.cornell.edu/~als93
Visit my web site for up-to-date info, homework assignments and handouts.