MECHANICS OF THE HUMAN LOCOMOTOR SYSTEM
EML 5595 - FALL 2005

Instructor: B.J. Fregly
Office: 208 MAE-A Building
E-mail: fregly@ufl.edu (preferred mode of communication)
Phone: (352) 392-8157
Home page: http://www.mae.ufl.edu/~fregly
Course home page: http://www.mae.ufl.edu/~fregly/eml5595.htm
(link provided off of Teaching page from Home page)

TA: Carlos Marquez-Barrientos
E-mail: carlos98@ufl.edu

Location: NEB 109 Computer Lab

Time: MWF Period 2

Office Hours: MWF Period 4

Texts: No existing course textbook does an adequate job of presenting the material to be covered in this course. Consequently, we will use two primary instructional resources – journal articles and software manuals. Students desiring additional background information may wish to purchase the two suggested reference books noted below.

Journal Articles: To allow you to learn and apply the most recent advances in musculoskeletal modeling and simulation, we will use carefully selected journal articles to present many of the concepts. As registered graduate students, you will be able to download all assigned articles for free from the University of Florida library web site.

Software Manuals: The other primary texts will be software user's manuals (see below for software details). In particular, the SIMM and SD/Fast user's manuals will provide an overview of musculoskeletal modeling and dynamic simulation concepts. Both manuals are free and will be made available for download as PDF files.

Suggested reference books:

Nigg, B. M. and Herzog, W. (1999) Biomechanics of the Musculo-skeletal System, Second Edition. John Wiley & Sons, New York.

Mow, V. C. and Huiskes, R. (2004) Basic Orthopaedic Biomechanics and Mechanobiology. Third Edition. Lippincott Williams & Wilkins, Philadelphia.

Software: Several software packages will be required to complete the modeling and simulation assignments in this course. All required software will be made available in the computer lab in NEB 109. The programs we will be using include the following:

- Software for Interactive Musculoskeletal Modeling (www.musculographics.com)
- SD/Fast Dynamic Simulation Software (www.sdfast.com)
- Microsoft Visual C++ (www.microsoft.com)

Course Design:

This course is modeled after the graduate course ME 382 "Modeling and Simulation of Human Movement" taught at Stanford University. Variations of this course are also taught at the University of Texas at Austin and the University of Wisconsin. The instructors from each of these courses (including the present course at the University of Florida) have agreed to share all course materials in order to create a world-class instructional opportunity. Consequently, you will be benefiting from extensive work done by instructors at four institutions while taking this course.

Course Prerequisites:

Ideally, students should have four prerequisites for this course:

- Dynamics
- Biomechanics
- Computer programming (C/C++ and Matlab)
- Initiative

Students without any background in dynamics should take EML 5215 "Analytical Dynamics" concurrently in order to develop an adequate understanding of the dynamics concepts that underlie the musculoskeletal modeling and simulation work. Students with little background in biomechanics should obtain an anatomy and physiology textbook to become familiar with musculoskeletal anatomy. Students without programming experience in C/C++ should purchase a good self-learning book on C programming or consider taking a C/C++ course concurrently. Due to the heavy computer simulation nature of the course, students will be required to take the initiative to search through lecture and lab notes, journal articles, and software manuals to complete assignments. This class will require significant effort, but it will also be a lot of fun.

Course Purpose:

The goal of this course is to teach you how to develop dynamic models, analyses, and simulations of human movement. Learning will be achieved through a series of lectures, journal article presentations, laboratory exercises, and a course project. The focus will be on the system involved in producing voluntary movement - the musculoskeletal system. Mathematical models will be developed for each component of the system and implemented in the SIMM musculoskeletal modeling and SD/Fast dynamic simulation software. Students will analyze computer simulations to gain insight into movement biomechanics and control.

Course Objectives:

By the end of this course, you should be able to do the following:

- *Musculoskeletal modeling*. Develop complex three-dimensional musculoskeletal models including joints (e.g., pin, ball and socket) and inertial properties that match subject-specific anatomy, ground contact models that predict interaction with the environment, and muscle-tendon actuators with force-length-velocity-activation properties.
- *Musculoskeletal analyses*. Calculate net torques and muscle moment arms about joints from experimental force and motion data using inverse dynamics principles, predict muscle forces and activations during movement using optimization principles, and analyze muscle function about spanned and unspanned joints by calculating individual muscle contributions to body segmental accelerations and mechanical powers.

- *Musculoskeletal simulations*. Create forward dynamic simulations of musculoskeletal motion that reproduce experimental movements and predict new movements and muscle activations for which no experimental data are available.

Policies and Procedures:

- ***Simulation Labs***. Simulation lab assignments will involve mathematical modeling of each component of the musculoskeletal system. Each lab will grow in complexity to build your musculoskeletal modeling capabilities. While you are encouraged to work together on lab assignments, copying of assignments is not permitted. After figuring out with others how to complete the assignment, each student must work individually to create and run his or her own computer code.

  When working on the simulation labs, you will be required to use the computers in NEB 109, since all of the required software has been loaded on those computers. An account for each student will be set up on all of the computers in NEB 109. However, you will not be able to save your work to the hard disk, so you will be required to bring a USB flash drive with you to save all your work. Some of the computers have zip drives that accommodate 100 MB zip disks (but NOT 250 MB zip disks). The door key code to NEB 109 will be provided in class.

- ***Course Project***. A final course project will be required involving modeling and simulation of the lower extremity. Students will choose a clinical or research situation to model (e.g., cerebral palsy surgery simulation, tibial osteotomy surgery simulation, space exercise simulation) as well as the specific issue to be addressed with the simulation. The project will be an excellent opportunity to apply what you have learned to a real-life problem. Each student will give a final project presentation during the last week of class. The presentations will be done in the environment of a "mini-conference", since the ability to explain and present a project is an important skill for any future position you will hold.

- ***Paper Presentations***. Each student will be assigned one or more journal articles to present to the class. This will help students internalize the material covered.

- ***Grading***. Since this course is built around computer simulations, grading will involve primarily simulation labs and the final project:

Simulation Labs	60%
Final Project and Presentation	30%
Paper Presentations	10%

  Late assignments will not be accepted. However, since difficult weeks will arise during the semester, each student will be permitted one late simulation lab (not applicable to the final project) turned in not more than one week after the original due date. Assignments and due dates will be given in class. Hardship cases will be considered on an individual basis and only if the instructor has been contacted *before* the due date of the assignment.

- ***Class E-mail Alias***. To facilitate communication with the class, the University will create an e-mail alias. In order to be included in the distribution list, you will need to have a xxx@ufl.edu e-mail address. You can check this by going to the University of Florida home page, clicking on Phonebook at the top of the page, and then searching for your name. If your e-mail address is not listed as xxx@ufl.edu, then you will need to contact the UF Computing Help Desk (helpdesk.circa.ufl.edu) to have this corrected during the first week of classes. If you do not have your e-mail address corrected,

then you will not receive potentially important e-mail distributions from the instructor to the class. Note that you can always forward your xxx@ufl.edu e-mail to some other e-mail address if desired.

- ***Class Attendance.*** You are personally responsible for all information disseminated during the lectures. This means knowing all assignment due dates and knowing all material, handouts, and announcements made in the lectures, whether or not you were present. Thus, if you miss a lecture, it is your responsibility to obtain all information presented during that lecture. "I missed that information" or "I was unaware of that information" will not be accepted as valid excuses.

- ***Academic Honesty.*** All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

  All students should read the University of Florida academic honesty statement available on the web at http://www.dso.ufl.edu/Academic_Honesty.html. Students are also encouraged to review the American Society of Mechanical Engineers' web site on ethics at http://www.asme.org/ethics/.

  Any student caught copying an assignment from others will receive a failing grade in the course. ALL incidents of possible cheating will be reported to the Office of Student Judicial Affairs. A formal review of the incident will be performed, and if found guilty, the student will receive a permanent mark on his or her transcript indicating an academic honesty violation in EML 5595. This result would be extremely detrimental for future employment or graduate school applications.

- ***Accommodation for Students with Disabilities.*** Students with disabilities who are requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

- ***UF Counseling Services.*** Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
  - University Counseling Center, 301 Peabody Hall, 392-1575, personal and career counseling.
  - SHCC Mental Health, Student Health Care Center, 392-1171, personal counseling.
  - Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
  - Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.
  - Alachua County Crisis Center, 264-6789, personal counseling.

- ***Software Use.*** All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.