

EML 5595

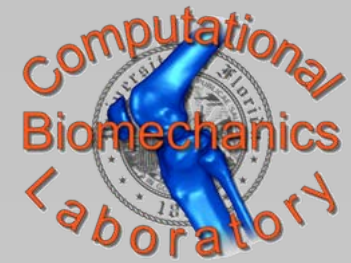
Mechanics of Human Locomotor System

Fall 2005

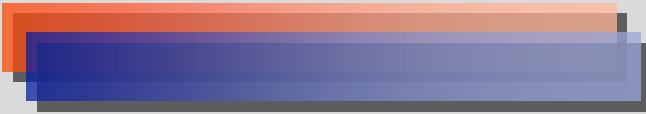
Instructor: Prof. B.J. Fregly
TA: Carlos Marques-Barrientos



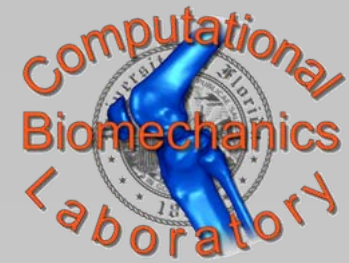
Outline



- Motivation
- Course Overview
- Syllabus
- Questions

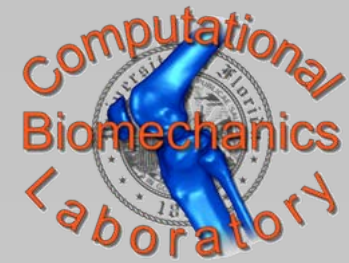


Motivation



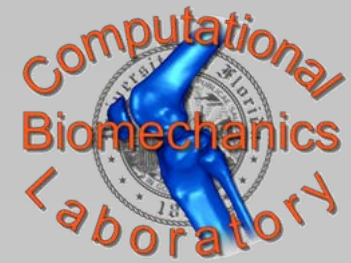
1. What real-life functional disorders can we address with the material in this course?
2. Why should we develop musculoskeletal models and simulations to address these issues?

Motivation



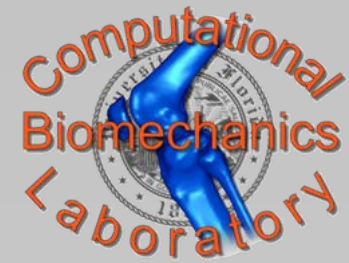
“Imagine a world where orthopedic surgeries are custom tailored to the patient, similar to how suits can be custom tailored to the business executive. Rather than basing surgical decisions on population studies or crude anatomic measurements, orthopedic surgeons interact with patient-specific computer models developed from medical imaging data and tuned to movement data collected from the patient prior to surgery. They use these models to predict the patient’s functional outcome for various combinations of surgical procedures, surgical parameters, and/or implant designs under consideration. The virtual human models use state-of-the art imaging, computational, simulation, and optimization technologies to allow the surgeon to optimize the surgical design variables. The end result is greatly improved functional outcome, more reliable surgical procedures, and millions of patients whose quality of life is improved through these technologies.”

Course Overview



- Lectures by professor
- Journal article reviews by students
- Simulation labs
- Course project

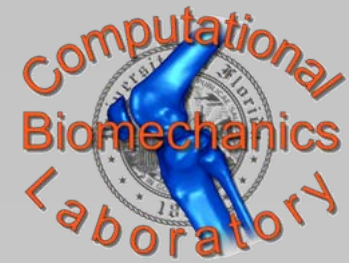
Why Reviews by Students?



Learning Method	Retention
What one reads	10%
What one hears	26%
What one sees	30%
What one sees and hears	50%
What one speaks	70%

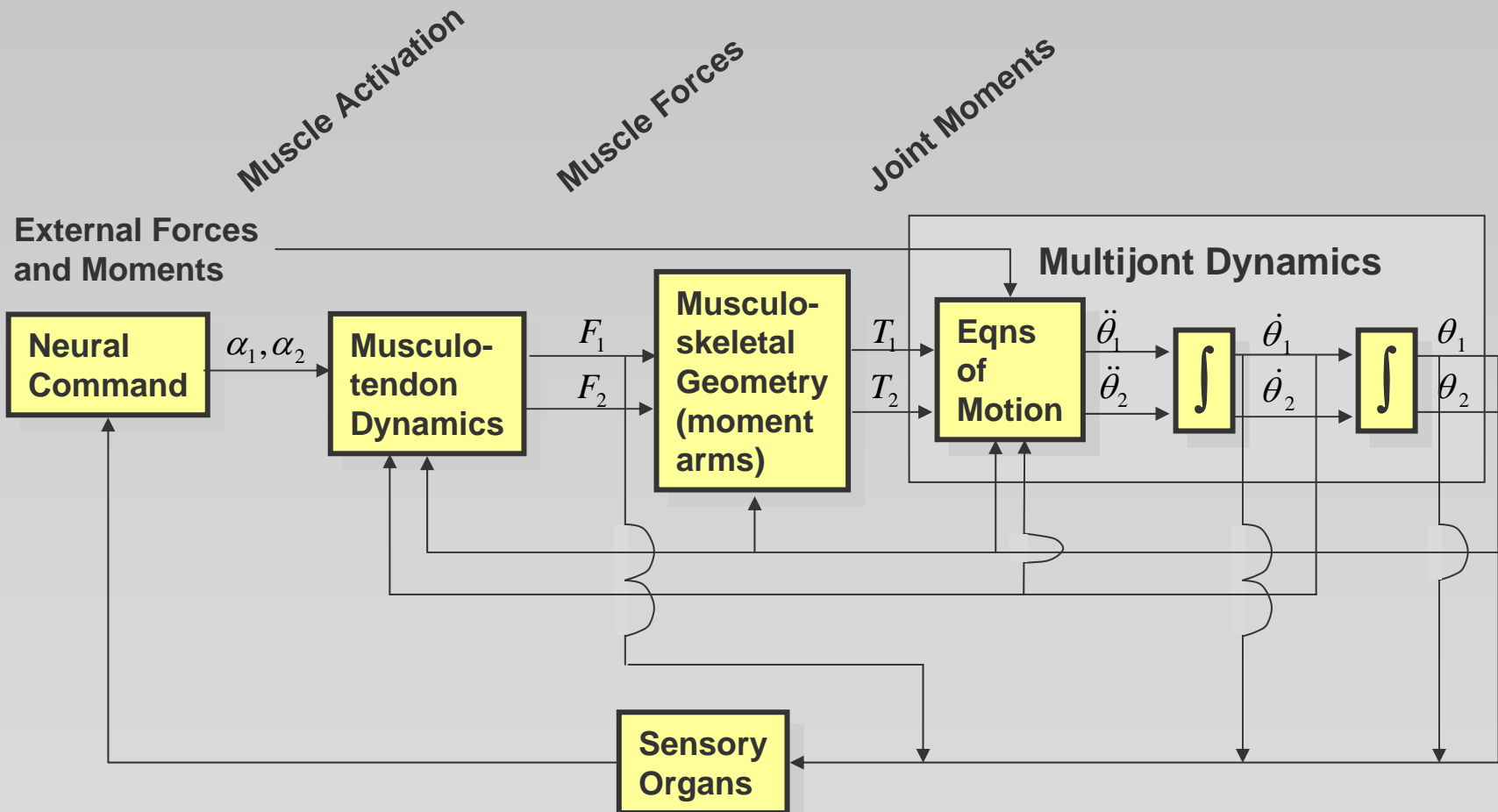
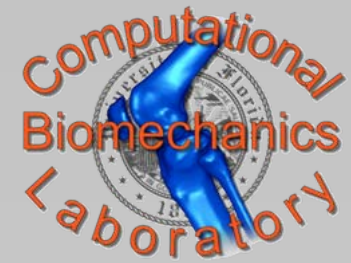
J. E. Stice (1987) *Engineering Education*, pp. 291-296

Preliminaries



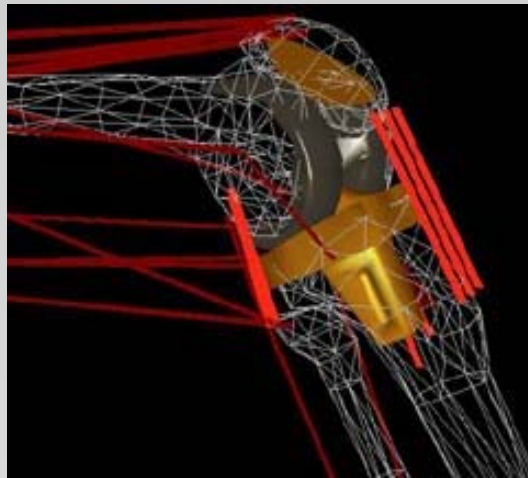
- This is the second time this course is being offered. We may need to make some adjustments on the fly. Please give feedback.
- Labs and project will be more open ended/research-like than normal classes.
- You will need to dig beyond lecture and lab notes to complete the assignments. This class will require significant effort.
- Be interactive! Contribute! Have fun!

Movement Production

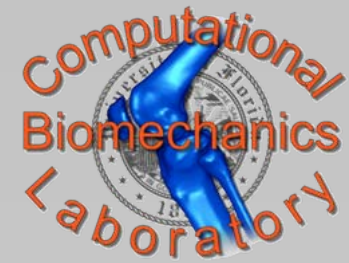


Simulation Software

- Software for Interactive Musculoskeletal Modeling (SIMM)
 - Defines muscle-tendon models
 - Defines muscle moment arms
 - Defines skeletal model structure

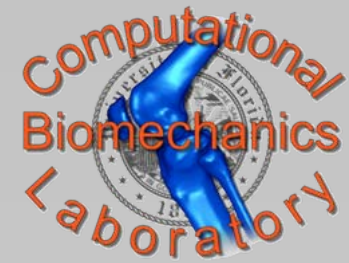


Simulation Software



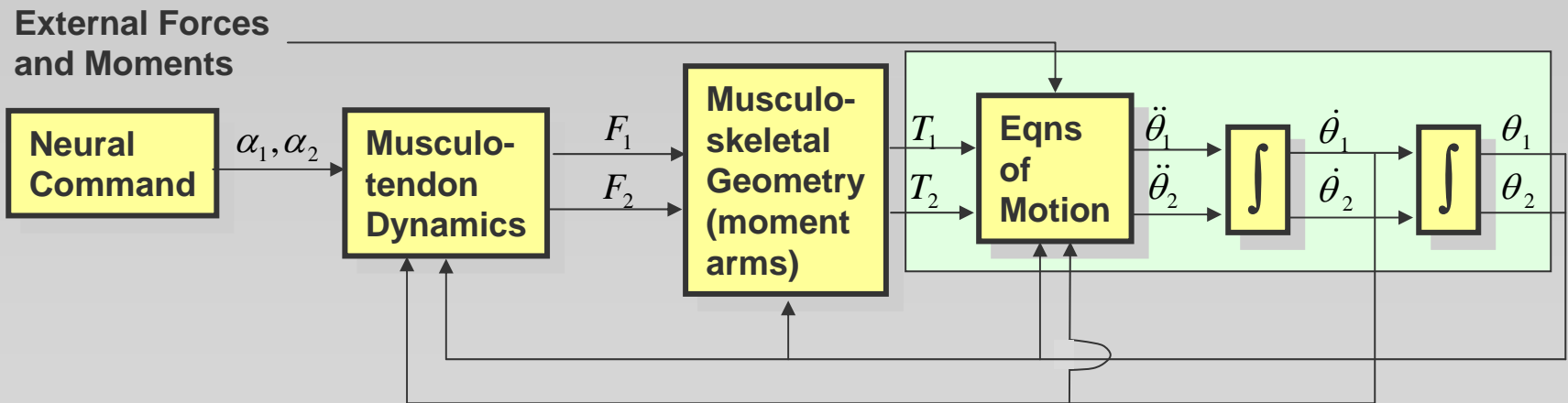
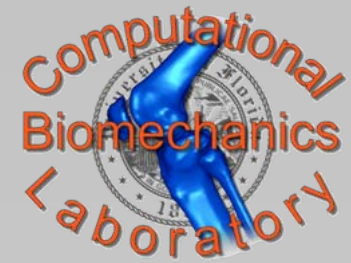
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- **SD/Fast (Symbolic Dynamics)**
 - Generates dynamics equations from input file
 - Provides C programming environment for performing dynamic simulations

Simulation Software

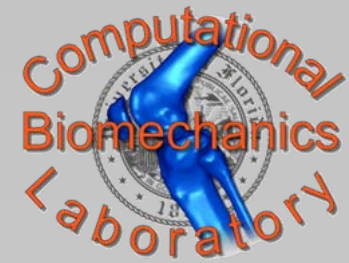


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 - Defines skeletal model structure
- SD/Fast (Symbolic Dynamics)
 - Generates dynamics equations from input file
 - Provides C programming environment for performing dynamic simulations
- **Dynamics Pipeline**
 - **Converts SIMM skeletal model structure into SD/Fast input file**
 - **Converts SIMM muscle-tendon and moment arm models into subroutines within the SD/Fast C programming environment**

Lab 1: Dynamic Simulation of Jumping



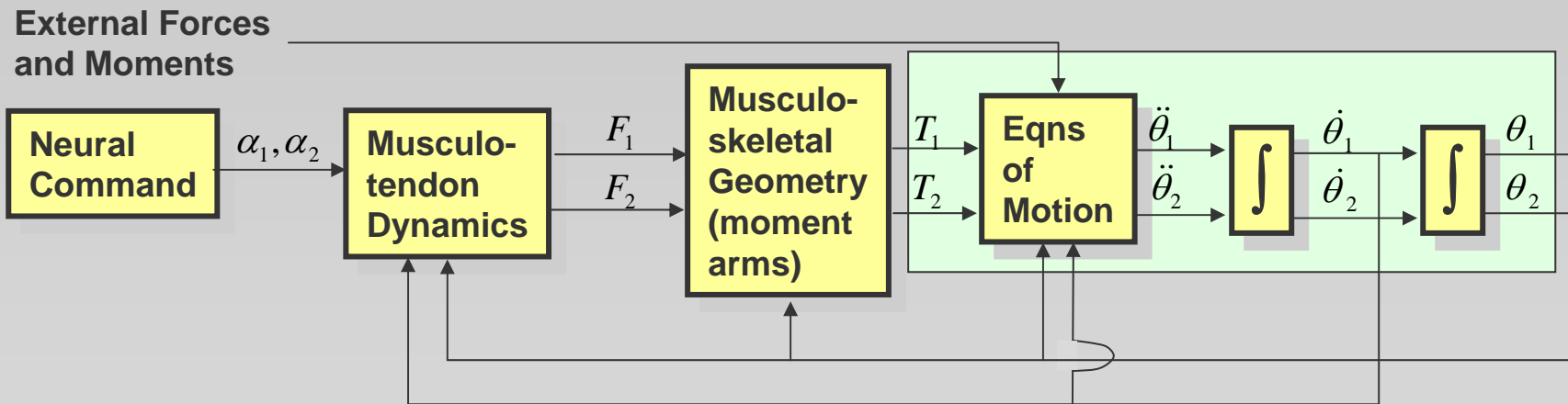
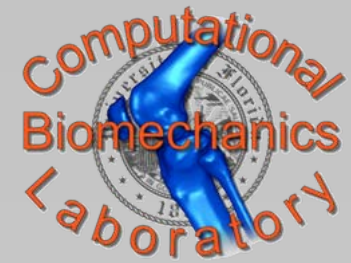
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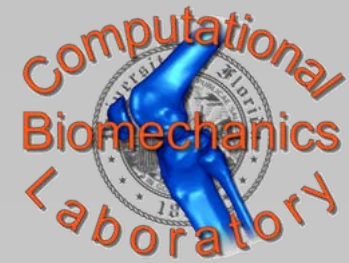
Objectives:

- Determine joint torque controls and initial joint angles to maximize jump height
- Evaluate sensitivity of simulations to changes in controls and initial conditions
- Study influence of muscles on the motion of unspanned joints
- Compare simulation predictions to experimental jump height

Lab 2: Torque-Driven Simulation of Swing Phase



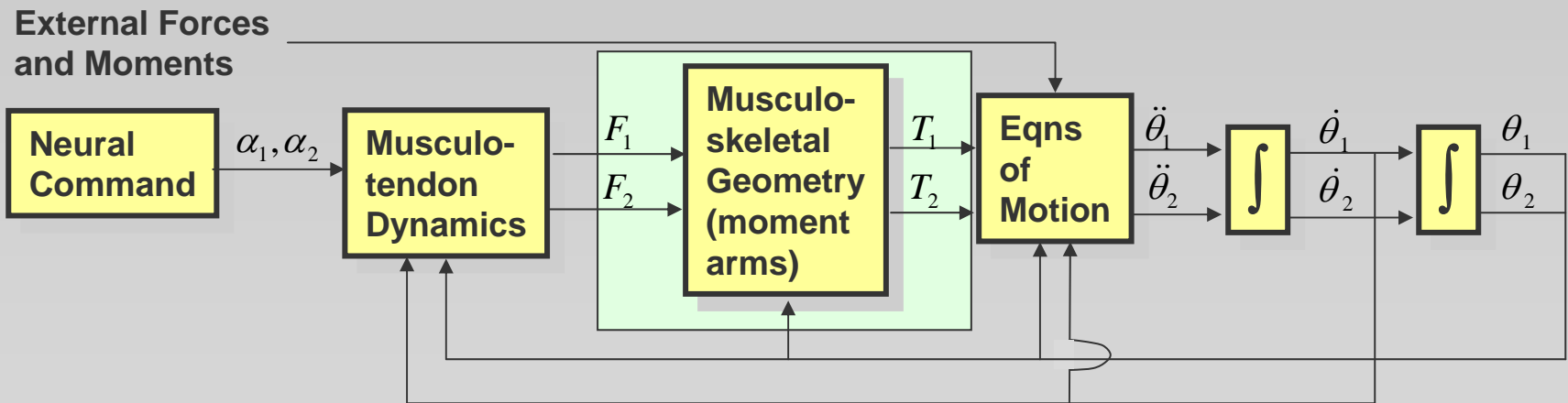
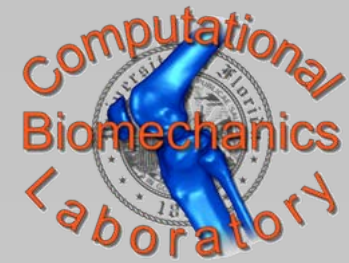
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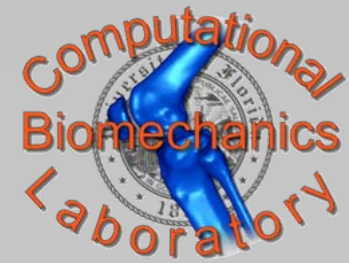
Objectives:

- Use SD/Fast to model dynamics and generate equations of motion
- Discover passive dynamics of swing
- Explore contributions of joint torques
- Examine causes of stiff knee gait

Lab 3: Modeling of Musculoskeletal Geometry



Lab 3: Modeling of Musculoskeletal Geometry

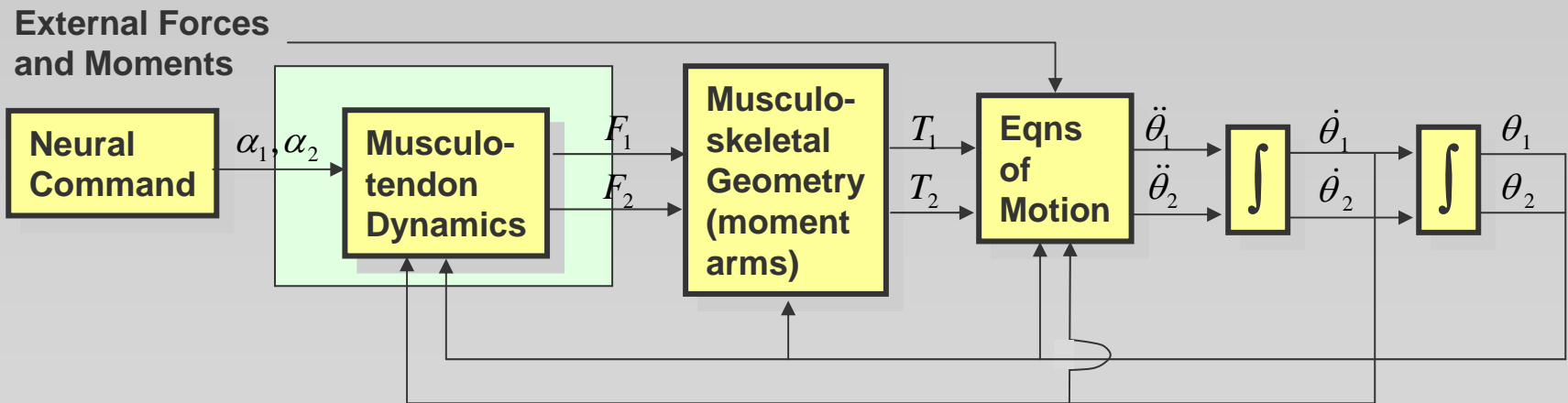
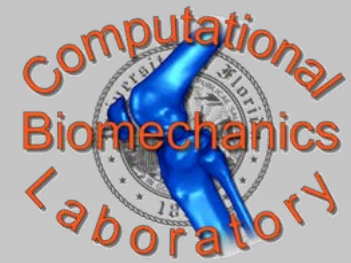


Objectives:

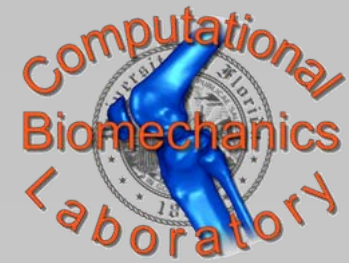
- Visualize 3D anatomy of selected structures of the lower limb
- Create a model of a muscle path
- Create models of simple and complex joints
- Introduce wrapping surfaces to represent muscles
- Assess accuracy of model by comparison with experimental data
- Describe analyses you could perform with this type of model



Lab 4: Muscle Tug of War



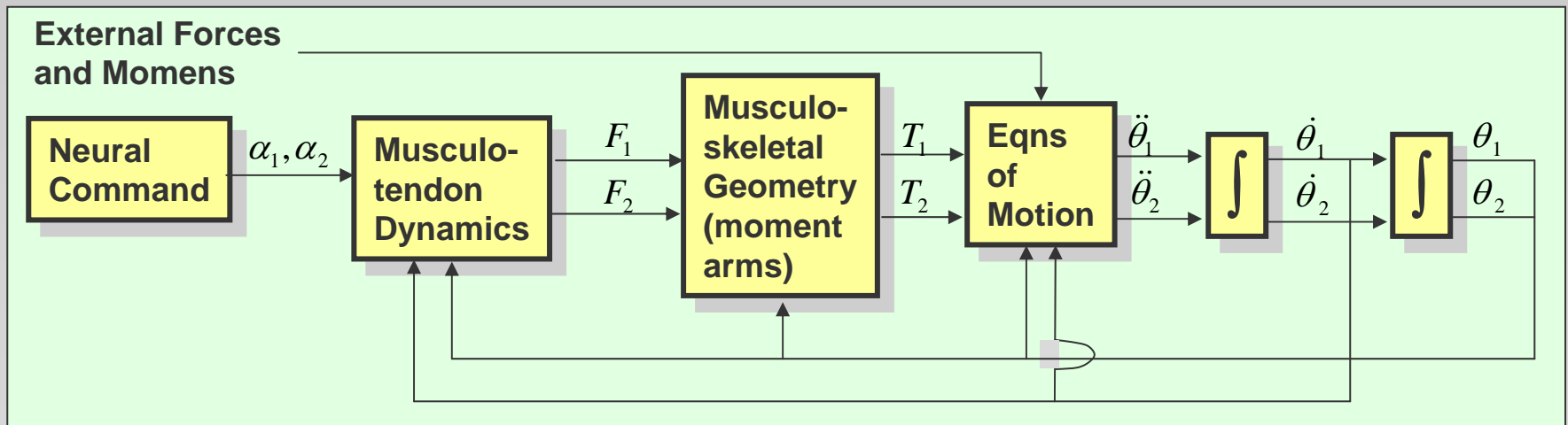
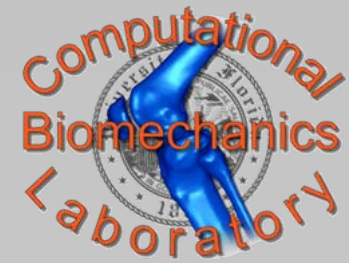
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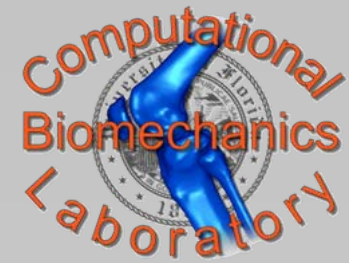
Objectives:

- Generate differential equations that describe muscle dynamics
- Use SIMM code to simulate dynamics
- Analyze the effects of model parameters on actuator performance

Lab 5: Muscle-Driven Simulation of Kicking



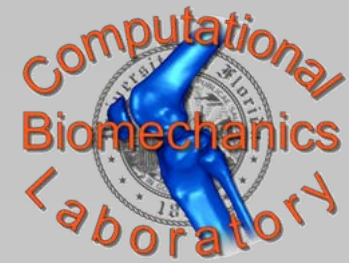
Lab 5: Muscle-Driven Simulation of Kicking



Objectives:

- Use SIMM and SD/Fast to generate equations of motion
- Prescribe muscle excitations to generate coordinated movement
- Study effects of abnormal control

Course Project



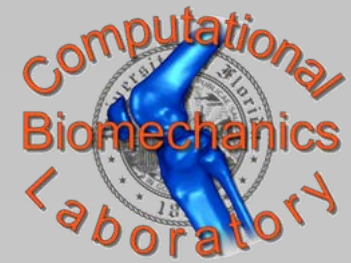
Each student will develop a course project related to a clinical problem. Some possibilities include:

- Stroke deficit analysis
- Paraplegic rehabilitation
- Cerebral palsy surgery simulation
- Tibial osteotomy surgery simulation
- Space exercise simulation

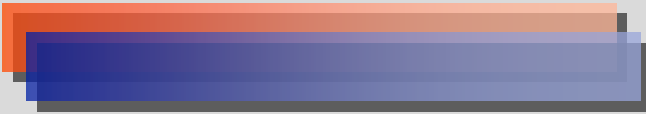
Outside research will be required to identify a problem of interest, so start early!



Syllabus

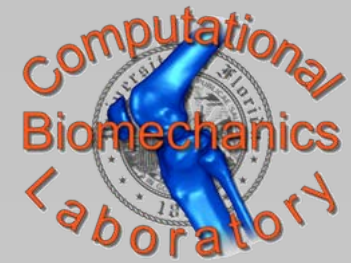


The syllabus is the contract between me and you. It lays out all important logistics related to this course. Make sure to read it carefully!

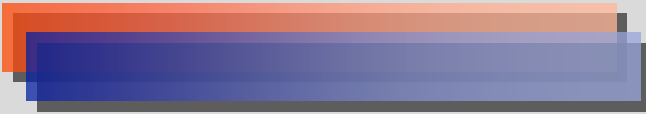




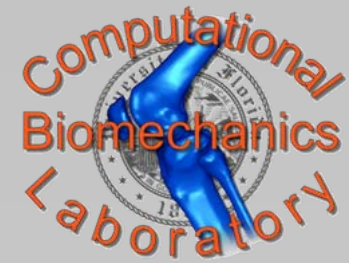
Questions



Questions are one the best ways to learn.
The only dumb question in this class is the
one you do not ask. Questions???



For Next Time



- Visit the course web site
<http://www.mae.ufl.edu/~fregly/eml5595.htm>
and familiarize yourself with the resources available for download
- Download and work through SIMM Tutorial 1
- Download and read Delp and Loan (2000)