Department of Kinesiology and Physical Education, McGill University

EDKP 566 – Advanced Biomechanics Theory

Fall 2018

Instructor: Ted Milner (theodore.milner@mcgill.ca)
Office: Currie Gym 334
Phone: 514-398-4184 ext. 0482
Office Hours: Monday 10:00-12:00, Thursday 12:00-1:00

Overview

This is an advanced course in musculoskeletal mechanics and biomechanics research techniques. Students will learn about motion analysis techniques and their limitations in studying human kinematics and kinetics. They will learn how to calculate net joint torque using inverse dynamics equations and the limitations of muscle force estimation techniques. They will learn how to record and interpret surface EMG. They will learn techniques for estimating the viscoelastic properties of joints and limbs and techniques for characterizing patterns of muscle activation. Patterns of muscle activation associated with a variety of motor tasks will be examined in the context of their contribution to force, motion and viscoelastic properties of limbs during posture and movement. Instrumentation will be explained and demonstrated and various analysis techniques will be introduced using Matlab. Students will be given the opportunity to apply their knowledge in a term project.

Format

Half of the class period will generally involve lecture or seminar presentations of assigned readings. The other half of the class period will be devoted to laboratory activities.

Assignments

Each student will be required to make a 10-minute seminar presentation followed by up to 5 minutes for questions. Readings for seminar presentations will be provided 2 weeks in advance. There will be 5 assignments involving analysis of motion capture data, force plate data and surface EMG recordings.

Term Project

Students will work in groups of two to estimate joint torques or internal forces for an activity of their choice (to be approved by the instructor) using data acquired from motion capture, force plates and/or surface EMG and to discuss the accuracy of the estimates. The results of the analysis will be presented orally and in a written report.

Grading

Seminar presentation 15%
Participation in question periods 5%
Assignments (5 x 10%) 50%
Lab Project 30%

Topics

Sept. 14 Introduction, Motion capture

- physical principles of measurement
- measurement instruments: potentiometers, goniometers, accelerometers, cameras, active markers, passive markers, emitter/receiver systems
- filtering and differentiation, coordinate systems, joint and segment motion, center of mass calculation

Lab: Introduction to Matlab (variables, operations, equations, matrices, input/output)
Matlab installation procedure

Sept. 21 Force/torque

- strain gauges, piezo-electric sensors, pressure sensors
- force plates, multi-axis force/torque sensors, center of pressure
- inverse dynamics applied to joints and limb segments

Lab: Matlab fundamentals (logic: if/else, while, for)

Sept. 28 EMG

- motor unit potentials, superposition, electrode filtering
- EMG quality, artefacts and noise
- EMG signal processing, filtering
- surface EMG recording technique

Lab: Matlab (plotting, figures)

Oct. 5 Muscle micromechanics

Lab: Optitrack basics, acquire motion capture data

Assignment 1 (Oct. 5 – Oct. 12)

Oct. 12 Muscle mechanics theory

Lab: Force plate basics, acquire ground reaction force data

Oct. 19 Biomechanical models

- joints
- muscles
- limbs

Lab: Record surface EMG under isometric and motion conditions

Assignment 2 (Oct. 19 – Oct. 26)

Oct. 26 Mechanical impedance

- moment of inertia
- joint stiffness, damping
- limb endpoint stiffness, damping

Lab: Matlab analysis techniques (event detection, min/max, differentiation, integration)

Assignment 3 (Oct. 26 – Nov. 2)

Nov. 2 Ultrasound techniques for investigating muscle-tendon mechanics

Lab: Matlab advanced analysis techniques (statistics, linear regression, cross-correlation)

Assignment 4 (Nov. 2 – Nov. 9)

Nov. 9 Student seminars

Assignment 5 (Nov. 9 – Nov. 16)

Nov. 16 Project activity

Nov. 23 Project activity

Nov. 30 Project presentations

Academic integrity and McGill Policies

McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/integrity for more information).

L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le

Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples reseignements, veuillez consulter le site www.mcgill.ca/integrity).

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

"In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change."