EDKP- 206 BIOMECHANICS OF HUMAN MOVEMENT (CRN 962)

Department of Kinesiology & Physical Education, McGill University

JANUARY-APRIL 2020 revised 20 March 2020

INSTRUCTORS: **David J Pearsall**, PhD, Associate Professor
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Graders: Harry Brown, Aimee Quintana

INSTRUCTIONAL METHOD:

The lectures will be 110 minutes and cover material listed in the course syllabus. **Currie 408**
Lab and tutorial sessions (110 minutes). **Currie Lab 304 and Computer Lab 207**

REQUIRED TEXT, READINGS and MATERIALS:

Oatis, Carol (2017) *Kinesiology: The Mechanics & Pathomechanics of Human Movement. 3rd ed.*
Required and recommended readings will be made available to students on myCourses at least one week in advance.
Scientific calculator

Description:
This course applies general principles of mechanics and math to analyze human movement. Students will explore the development of forces within muscles, the strength properties of bones, the variety of joint designs and resulting different rotational degrees of freedom, and how all of these initiate and control human movement. These concepts will be applied to understand human posture and movement mechanics along a continuum from athletic to normal to pathological, and across the lifespan from child to adult to elderly.

COURSE DETAILS

Learning Format: Lecture, Lab
Contact Hours: 2 hr Lectures, 2 hr Lab per week
Semester Length: 13 weeks
Prerequisite background courses PHYS 101 or PHYS 1313.

COURSE CURRICULUM

Learning Outcomes
Upon completion of this course, students will be able to:

1. Apply knowledge of human anatomy to describe human movement in both anatomical and mechanical terms.
2. Describe the mechanical properties of the tissue building blocks of the musculoskeletal system
3. Describe the fundamental mechanical principles applicable to analyzing human movement and posture.
4. Describe tools (hardware, electronics, software) used to acquire and quantify human movement and show an understanding of their diagnostic strengths and limitations.
5. Discuss the biological and physical mechanisms related to
    a. Independent daily living functions
    b. Manifestation of injury as they relate to internal and external forces
    c. Augmentation of human function by physical and athletic training
    d. Children, adults and elderly
    e. Motor control
6. Derive and solve equations of human motion in two dimensions.
7. Draw and use the concept of a free-body diagram as it applies to human movement.
8. Explain how forces are generated by the muscle-tendon complex.
9. Interpret graphs and simple models used to explain human movement.
10. Apply related peer-reviewed research to interpret data collected.
11. Apply active learning, critical thinking, and problem solving skills in the qualitative analysis of human movement.

COURSE CONTENT

1. **Anatomical concepts to describe human movement**
1.1. Movements in the sagittal, frontal and transverse planes.
1.2. Movements occurring about the medio-lateral, antero-posterior and longitudinal axis.
1.3. Muscle, bones and joints with the correct terminology.
1.4. Degrees of freedom at a joint based on its anatomy.
1.5. Proper terminology to describe human movement.

2. **Describing human movement – Kinematics**
2.1 Kinematic variables using vector analysis to quantify human movement.
2.2 Problems in 2-dimensions involving: displacement, velocity, acceleration, time.
2.3 Factors that affect the trajectory of a projectile.
2.4 Free-body diagrams to illustrate the variables that affect the trajectory of a projectile.
2.5 Graphical interpretation to determine relationships between kinematic variables in 2-dimensions.
2.6 Peer-reviewed research applied to the interpretation of kinematic data.
2.7 Tools used to acquire human movement data.

3. **Forces that change motion – Kinetics**
3.1. Kinetic variables to the quantification of human movement.
3.2. Problems in 2-dimensions involving: mass, force, friction, acceleration, moment of inertia, work, power, energy, momentum and impulse for both linear and angular movements.
3.3. Free-body diagrams to understand the net effect of forces on a body or system. These free-body diagrams are used to solve problems involving balanced or unbalanced forces and objects on inclined surfaces.
3.4. The role that play internal and external forces in the development of acute and chronic injuries.
3.5. Graphical interpretation to determine relationships between kinetic variables.
3.6. Peer-reviewed research applied to the interpretation of kinetic data.
3.7. Kinetic data collection with the appropriate tools.

4. **Muscle-Tendon Complex (MTC) – generators of force**
4.1. The elements of the human musculo-skeletal system and how the system's properties interact during human movement.
4.2. How muscles generate forces and their effect on the structures surrounding them.
4.3. Concepts of force-length, force-velocity, hysteresis, compression, tension, shear, strain and Young's Modulus to explain musculo-skeletal adaptation.
4.4. The interaction of the mechanical properties of the musculo-skeletal system as they affect human movement.
4.5. Collecting data using surface electrodes over appropriate anatomical landmarks during a range of human movements.
4.6. The conceptual framework for EMG analysis of human movement and the physiological and biomechanical basis for recording electrical potentials from striated muscles using surface electrodes.

Methods of Instruction
- Lecture
- Discussion group
- Audio-visual presentations
- Labs – data collection, analysis and presentation
- Critical thinking and problem solving
- Work stations
- Demonstrations

Means of Assessment
Evaluation will be carried out in accordance with McGill University policy.
The instructor will present a written course outline with specific evaluation criteria at the beginning of the semester.
Due to the extraordinary circumstances of COVID-19, after March 30th the course will be delivered in an online format (via Zoom, pre-recorded lectures, and myCourses).

EVALUATION will be based on the following criteria:

Assignment	Due Date	% of total grade
Participation	-	10 ~~5~~%
Online Quizzes/Lab Assignments	Prior to the following lab or lecture	30 ~~20~~% (total)
Midterm Exam	Week 8	40 ~~25~~%
~~Group Project~~ CANCELLED	~~Week 13~~	~~15%~~
Final Exam online, open book	28 April ~~TBD~~	20 ~~35~~%

Participation: Participation will be scored based on participation within lab discussions and activities throughout the semester. Having more than 2 unexcused absences will result in a reduction of total participation grade. Participation is worth 10 ~~5~~% of the total course grade.

Lab Assignments: Lab assignments (4 total) assess learning of concepts pertaining to data collection/analysis and are to be completed in groups assigned during the first lab session. Groups will work together to complete assignments and submit one final copy to myCourses prior to the start of the following lab session. Each individual assignment is worth 3~~2~~% of the total course grade.

Online Quizzes: Online quizzes (6 total) assess learning of lecture or lab material and will be available on myCourses following the lab or lecture they pertain to. Quizzes must be completed before the start of the following lab or lecture. These quizzes are to be completed individually and consist of 1-10 short questions intended to highlight important concepts. Each individual quiz is worth 3~~2~~% of the total course grade.

Midterm Exam: This exam is composed of multiple-choice questions, short answer, and calculation questions intended to assess students' learning of lecture and lab content. The midterm exam includes a combination of lab and lecture material from week 1 to week 7 of the course. The midterm exam is worth 40% of the total course grade.

Group Project: CANCELLED

Final Exam: This exam will be comprised of multiple-choice questions, short answer, and calculation questions intended to assess students' learning of lecture and lab content. The final exam will ~~be a cumulative exam including a combination of lab and lecture material from the entire course with emphasis placed on weeks 9-12.~~ The final exam is worth 20 ~~35~~% of the total course grade

IMPORTANT DATES AT MCGILL: https://www.mcgill.ca/importantdates/key-dates

Classes Start	Jan 6, Monday
Reading Week	March 2-6
Classes end	April 14, Tuesday
FINAL EXAMS	April 17 to 30
Good Friday	April 10
Easter Monday	April 13

ACADEMIC STATEMENTS:

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. This right applies to all written work that is to be graded, from one-word answers to dissertations. Instructor addition: French/English dictionaries will be permitted during exams (however, supplemental notes marked within the dictionary will not be tolerated, see following statement of academic integrity).

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/students/srr/honest/ 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 renseignements, veuillez consulter: www.mcgill.ca/students/srr/honest/).

Instructors who may adopt the use of text-matching software to verify the originality of students' written course work must register for use of the software with Educational Technologies (support.ist@mcgill.ca) and must inform their students before the drop/add deadline, in writing, of the use of text-matching software in a course.

ACADEMIC EXPECTATIONS:

- *Check MyCourses for notes prior to attending lecture*
- *Please read the required text. It will add to the framework of class slides.*
- ***If you do not understand something, please ask!***
- *Requests for supplemental assignments to raise grades will NOT be accepted*

Lecture and Laboratory Schedule (2020)

	Monday	Tuesday	Wednesday	Thursday
8am				
		EDKP 206-002		
		3507 -		
9am		8:35 AM-10:25 AM		
		CURRIE 304		
10am				
		EDKP 206-003	EDKP 206-001	
		963 -	962 1 times 2 hrs/wk	
11am		**10:35 AM-12:25 PM**	10:35 AM-12:25 PM	
		CURRIE 304	CURRIE 408/9	
12pm				
				EDKP 630-001
				21378 1 times 3 hrs/wk
1pm				12:35 PM-3:25 PM
				CURRIE 352
2pm				
3pm		EDKP 206-004		
		964 -		
		3:05 PM-4:55 PM		
		CURRIE 304		
4pm				

TENTATIVE COURSE SCHEDULE EDKP 206 2020 (revised March 20)

Week	Date	Topic (labs/lecture)	Prior to Class	Out of Class
1	Jan 7	Free body diagrams: intro to forces and moments	MyCourses article **Bring calculator**	Practice problems
	Jan 8	Introduction to Biomechanical Analysis Mechanical Properties of Materials Biomechanics of Bone	Oatis Ch. 1-3	Online quiz
2	Jan 14	FBD 2: calculating joint reaction forces and moments	Complete practice probs – write down any questions **Bring calculator**	Practice Problems
	Jan 15	Biomechanics of Tendons and Ligaments	Oatis Ch. 6	Online quiz
3	Jan 21	Work, Power, & Energy Quantitative kinematic video analysis	Download Dartfish	Lab Assignment 1
	Jan 22	Biomechanics of Cartilage	Oatis Ch. 5	Online quiz
4	Jan 28	Electromyography (EMG)	My Courses article	Lab Assignment 2
	Jan 29	Biomechanics of Skeletal Muscle Electromyography	Oatis Ch. 4	Online quiz
5	Feb 4	Ground Reaction Force/Balance/Center of Pressure	MyCourses article	Lab Assignment 3
	Feb 5	Hip structure, function, analysis of forces during activity	Oatis Ch. 38-40	
6	Feb 11	Walking/Running Gait Video Analysis & Interpreting Gait Waveforms	MyCourses article	Lab Assignment 4
	Feb 12	Knee, Ankle & Foot structure, function, analysis of forces during activity	Oatis Ch. 41-43 Oatis Ch. 44-46	
7	Feb 18	Inverse Dynamics	**Bring calculator** Submit review questions for midterm to myCourses	Online Quiz Study for midterm
	Feb 19	Midterm Review (jeopardy, kahoots, etc)		
8	Feb 25	No labs		
	Feb 26	MIDTERM 25%		

Week	Date	Topic (labs/lecture)	Prior to Class	Out of Class
9	Mar 10	3D Motion Capture tutorial & demo	MyCourses article	
	April 1-3	Characteristics of Normal Gait Inverse Dynamics Running Mechanics	Oatis Ch. 47, 48	**Refer to MyCourses or Youtube lecture link online *(for students to view independently)*:**
~~10~~	~~Mar 17~~	**CANCELLED** ~~Introduce group project~~		~~Prepare for group project (begin to search literature)~~
	~~Mar 18~~	**CANCELLED** ~~Lumbar spine structure, function, analysis of forces during activity Normal posture and postural abnormalities~~	~~Oatis Ch. 32-34~~	
~~11~~	~~Mar 24~~	**CANCELLED** ~~Group Project Prep~~	~~Email finalized groups and topic to TA~~	~~Complete presentation~~
	~~Mar 25~~	**CANCELLED** ~~Shoulder and Elbow structure, function, analysis of forces during activity~~	~~Oatis Ch. 8-10~~ ~~Oatis Ch. 11-13~~	
~~12~~	~~Mar 31~~	**CANCELLED** ~~Group Project Presentations 15%~~		~~Submit proposal~~
	~~Apr 1~~	**CANCELLED** ~~Wrist & hand structure, function, analysis of forces during activity~~ ~~Mechanics and patho-mechanics of pinch & grasp~~	~~Oatis Ch. 14-16, 19~~	~~Online quiz~~
~~13~~	~~Apr 7~~	**CANCELLED** ~~Group Project work day – optional (written project)~~		
	~~Apr 8~~	**EXAM Review (Zoom) new date(s) to be announced on MyCourses**	~~Submit review questions for final to myCourses~~	~~Study for final exam~~

An alternative format for the final exam is being explored so that it will not involve an in-person sit-down examination on campus. Details on the final exam will be communicated to students as soon as clear information becomes available.

Tentatively, The FINAL EXAM will be ONLINE and OPENBOOK and will be on the original date 28 April 2020

Note: Appointments will be held virtually after March 30th (instructions for attending virtual office hours and appointments with your instructor will be posted on myCourses).