EDKP- 206 BIOMECHANICS OF HUMAN MOVEMENT (CRN 962)

Department of Kinesiology & Physical Education, McGill University

JANUARY-APRIL 2022

INSTRUCTORS: **David J Pearsall**, PhD, Associate Professor
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Graders: Samuel Tremblay, Laura Holman, Kristin Higgins

COURSE LOCATION and TIME

Please note that all lectures and labs will be delivered via Zoom until further notice.

Lectures
Though the lecture is officially scheduled on Mondays 3:35-5:25pm, some lecture content will be pre-recorded and posted on myCourses at least 48 hours in advance of the scheduled time. We recommend viewing this content prior to the synchronous portion of the course.
Synchronous student participation is expected via Zoom on the day of each lecture.
*When in-person classes resume, lectures will be held in Currie 408 during the scheduled lecture time.

Labs
Labs are officially scheduled on Tuesdays Section 2 9:35-11:25am, Section 3 2:35-4:25pm, Section 1 Thursdays 9:35-11:25am.
Synchronous student participation is expected via Zoom for each section. **Students may not attend labs other than their scheduled lab section unless instructor permission is granted in advance.**
*When in-person classes resume, labs will be held in Currie 304 (Tassone Lab) during scheduled lab times.

REQUIRED TEXT, READINGS and MATERIALS:

Oatis, Carol (2017) *Kinesiology: The Mechanics & Pathomechanics of Human Movement. 3rd ed.*
Required and recommended readings are listed for each weekly lecture and lab session in the course calendar.
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
• Workstations
• Demonstrations

EVALUATION SUMMARY

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.
Evaluation will be based on the following criteria:

Assignment	Due Date	% of total grade
Participation	Jan 17, Feb 3, Feb 14, Mar 24, Apr 7	5%
Reports (5% x 4)	Jan 31, Mar 7, Mar 28, Apr 15	20%
Midterm Exam	Week 7 – Feb 21	25%
Group Project	Presentation recordings due Apr 11	15%
Final Exam	TBD	35%

Participation: Participation will be scored based on c*ompletion* of participation "quizzes" to be taken through myCourses. Participation is worth 5% of the total course grade.

Reports: You are required to submit four reports which track your progress in the course (approximately every three weeks; see calendar). Reports should be typed using Microsoft Word templates that are available on myCourses; there are separate templates for Reports 1, 2, 3, and 4. They should be submitted via myCourses by the due dates listed on myCourses and in the calendar. Up to 5 points will be awarded per report (20 points total), based on one's level of engagement, timely progress, and thoughtfulness.

> *Discussion Board Posts (Reports 2 & 4)*: To help facilitate student engagement, we will be using the Discussion Board within myCourses. Each student is expected to write at least two brief posts – one in the first half of the term and one in the second half. Posts should be brief and can include, for example, (a) insights or information that stand out to you in your course engagement, (b) a brief summary of an academic article you found interesting, (c) a brief summary of a news article or other media to bring to your classmates' attention. Students are encouraged to comment on posts and engage with each other through the Discussion Board, and you are also welcome to write additional posts if you wish.

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 6 of the course. The midterm exam is worth 25% of the total course grade.

Group Project: The final group project assesses the students' understanding of key biomechanical concepts, the ability to assess existing scientific literature, and think critically to create a research question. Students will work in groups to create a biomechanical research question related to a selected topic. Students will be responsible for an oral presentation recorded in advance via Zoom and submitted via myCourses by April 11, as well as a live Q&A session during their regularly scheduled lab time. Presentation should include the following: literature review (including knowledge gap), research question, hypothesis, and proposed methods (including participant information, data collection procedures, rationale for biomechanical analysis methods, and limitations).

In addition to your presentation video, each group will submit one brief Word document listing the contributions of each individual group member to the project.

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 8-12. The final exam is worth 35% of the total course grade.

Late Assignments: Assignments submitted after their deadline will be eligible to receive up to 80% of the original point value for the assignment. Submissions later than 1 week after the deadline will not be accepted. Participation quizzes may not be submitted late.

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

Winter 2022

Key Academic Dates & Other Important Dates

The Key Academic Dates found below are those approved by Senate in November 2020.

- **Classes begin**: Wednesday, January 5
- **Winter Reading Break**: from February 28 to March 4 (*some exceptions apply*)
- **Classes end**: Tuesday, April 12
- **Study Days**: Saturday, April 9 to Sunday, April 10; Friday, April 15 to Monday, April 18
- **Exams begin**: Wednesday, April 13
- **Exams end**: Friday, April 29 (11 days, including evening exams)

Other important dates built around the Key Academic Dates include:

- **Deadline to cancel registration**: Friday, December 31, 2021
- **Deadline to register without penalty** (new students only): Wednesday, January 5
- **Add/Drop deadline**: Tuesday, January 18
- **Course or University Withdrawal with refund deadline**: Tuesday, January 25
- **Course or University Withdrawal WITHOUT REFUND deadline**: Tuesday, March 8

Legal holidays. Administrative offices are closed on the following dates:

- **Good Friday**: April 15, 2022
- **Easter Monday**: April 18, 2022

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/).

LAND ACKNOWLEDGEMENT:

McGill University is situated on the traditional territory of the Kanien'kehà:ka, a place which has long served as a site of meeting and exchange amongst many First Nations including the Kanien'kehà:ka of the Haudenosaunee Confederacy, Huron/Wendat, Abenaki, and Anishinaabeg.

TENTATIVE COURSE SCHEDULE EDKP 206 2022

Week	Date	Topic (lecture/lab)	Prior to Class	Out of Class
1	Jan 10	Introduction to Biomechanical Analysis Mechanical Properties of Materials Biomechanics of Bone	Oatis Ch. 1-3 What Is Biomechanics (YouTube)	
	Jan 11,13	Free body diagrams: intro to force & moments	**Need calculator** Review Oatis Ch. 1	Participation Quiz 1 Week 1 Problem Bank (optional)
2	Jan 17	Biomechanics of Tendons and Ligaments	Oatis Ch. 6 **Submit Participation Quiz 1**	
	Jan 18,20	Free body diagrams: calculating joint reaction forces and moments	**Need calculator**	Week 2 Problem Bank (optional)
3	Jan 24	Biomechanics of Cartilage	Oatis Ch. 5	
	Jan 25,27	Work, Power, & Energy	Crash Course Video (YouTube)	Complete Report 1 Participation Quiz 2 Week 3 Problem Bank (optional)
4	Jan 31	Biomechanics of Skeletal Muscle Electromyography	Oatis Ch. 4 **Submit Report 1**	
	Feb 1,3	Electromyography (EMG)	**Submit Participation Quiz 2**	Week 4 Problem Bank (optional)
5	Feb 7	Hip structure, function, analysis of forces during activity	Oatis Ch. 38-40	
	Feb 8,10	Ground Reaction Force/Balance/Centre of Pressure		Participation Quiz 3 Week 5 Problem Bank (optional)
6	Feb 14	Knee structure, function, analysis of forces during activity	Oatis Ch. 41-43 **Submit Participation Quiz 3**	Week 6 Problem Bank (optional)
	Feb 15,17	Midterm review		
7	Feb 21	Midterm		
	Feb 22,24	No labs		Complete Report 2
Reading Week Feb 28- Mar 4				

Week	Date	Topic (lecture/lab)	Prior to Class	Out of Class
8	Mar 7	Ankle & foot structure, function, analysis of forces during activity	Oatis Ch. 44-46 **Submit Report 2**	
	Mar 8,10	Walking/Running Gait Video Analysis & Interpreting Gait Waveforms		Week 8 Problem Bank (optional)
9	Mar 14	Characteristics of Normal Gait Inverse Dynamics Running Mechanics	Oatis Ch. 47, 48	
	Mar 15,17	Qualitative kinematic video analysis	Download Kinovea	Participation Quiz 4 Week 9 Problem Bank (optional)
10	Mar 21	Lumbar spine structure, function, analysis of forces during activity Normal posture and postural abnormalities	Oatis Ch. 32-34	
	Mar 22,24	3D Motion Capture + create groups for project	**Submit Participation Quiz 4**	Complete Report 3 Week 10 Problem Bank (optional)
11	Mar 28	Shoulder structure, function, analysis of forces during activity Elbow structure, function, analysis of forces during activity	Oatis Ch. 8-10 Oatis Ch. 11-13 **Submit Report 3**	Week 11 Problem Bank (optional)
	Mar 29, 31	Introduce Group Project		
12	Apr 4	Wrist & hand structure, function, analysis of forces during activity Mechanics and patho-mechanics of pinch & grasp	Oatis Ch. 14-16, 19	Participation Quiz 5 Week 12 Problem Bank (optional)
	Apr 5,7	Group Project Prep	Email finalized groups and topic to TA	**Submit Participation Quiz 5 by 6pm on April 7**
13	Apr 11	Final Review	**Submit presentation recordings**	Complete Report 4, **due April 15**
	Apr 12,14	Group Project Viewing & Live Q&A's		
	TBD	FINAL EXAM 35% between April 18 to 29		