

HK*2270 Human Biomechanics
Fall 2016 Tentative Outline
Department of Human Health and Nutritional Sciences
College of Biological Science

Course Description

Application of mechanical principles to the study of human movement.

Topics include: anthropometrics, biological tissue tolerance, muscle force generation, static and dynamic equilibrium, work/energy and impulse/momentum as they apply to the description of motion, injury of musculoskeletal tissues and optimization of human performance. Students should have knowledge of basic trigonometry, mechanics principles from the prerequisite physics classes (PHYS*1080 or PHYS*1000).

Teaching Team

Instructor: Dr. Lori Ann Vallis Email: lvallis@uoguelph.ca

Office: Animal Science/Nutrition Building (ANNU) Room 343, ext. 54589

Office hours: Tuesday, 11:30 – 2:00 p.m. or by appointment.

Teaching Assistants:

Paula Miotto (pmiotto@uoguelph.ca)

Emily McIntosh (emcint03@uoguelph.ca)

*Erika Howe (ehowe01@uoguelph.ca) [Sept to Midterm Exam];

*Shawn Beaudette (sbeaudet@uoguelph.ca) [Midterm Exam to Final Exam]

Course Schedule

LECTURE HOURS: Tuesday & Thursday 10:00 am – 11:20 am **ROZH 103**

TUTORIALS:

Wednesday Section 101 (9:30-10:20 am) in **MACN 118**

Wednesday Section 102 (12:30-1:20 pm) in **ALEX 028**

Wednesday Section 103 (2:30-3:20) in **MACN 118**

Thursday Section 104 (1:30-2:20) in **MACN 118**

Thursday Section 105 (2:30-3:20) in **MACN 118**

Learning Goals

By the end of this course, students should be able to, i) describe the fundamental mechanical static and dynamic principles underlying human movement, ii) interpret human movement characteristics using basic descriptive qualitative techniques and quantitative assessment methods to compute forces and moments which generate human movement, iii) demonstrate knowledge of anthropometrics and biological tissue tolerance as it pertains to injury of musculoskeletal tissues, iv) apply the concepts of work/energy and impulse/momentum and compute these variables to describe motion and the optimization of human performance.

Course Resources

CourseLink

Lecture notes are the required reading for the course. **Partially completed** lecture slides will be posted on [CourseLink website](#) prior to the next week's lectures. It is your responsibility to print these slides and bring them to class with you as they will assist in lecture note taking and problem solving examples carried out in lecture.

Please familiarize yourself with the [Rights and Responsibilities](#) of all users prior to using CourseLink.

Reference Texts

The following text is *recommended* for this course and is available for purchase in the University of Guelph Bookstore.

D. Gordon E. Robertson, *Introduction to Biomechanics for Human Motion Analysis* (2nd edition).
Publisher: Waterloo Biomechanics, Waterloo ON. ISBN : 0-9699420-2-8

Other texts may be helpful as references on occasion and can be found in the library (note, they are **not** on reserve).

- S. Hall, *Basic Biomechanics*. Publisher: St. Louis, Toronto; Mosby (1995), 6th edition.
- M. Nordin and V.H. Frankel, *Basic Biomechanics of the Musculoskeletal System*. Publisher: Lippincott Williams & Wilkins. (2001) 4th edition.
- J. Hamill and K. Knutzen, *Biomechanical Basis of Human Movement*. Publisher: Lippincott Williams & Wilkins. (2009), 3rd edition.

Course Content

Introduction

- Definitions, relevance and applications of biomechanics

Review of physics

- Force and moments, work, energy, momentum, power
- Vector vs. scalar, sine/cosine functions, essential math functions

The Human Biological System

- Strength of human tissues
- Skeletal muscle mechanics
- Anthropometry and body segment data: methods of estimation, use in kinematic and kinetic calculations,

Statics

- static equilibrium
- free body diagrams
- bone-on-bone forces (compression, shear, etc.)

Kinematics (motion that results from forces)

- vector representations

- linear vs. angular motion: displacement-velocity-acceleration equations
- quantifying segment motion
- absolute vs. relative motion

Kinetics (forces that cause motion)

- muscle mechanics revisited
- impulse/momentum approach
- linear vs. rotation momentum
- conservation of momentum
- work/energy approach
- efficiency, power calculations
- $F = ma$ approach
 - dynamic equilibrium
 - inverse vs. forward solutions
 - free body diagrams and bone-on-bone forces revisited

Course Structure

Presentation timing of lecture and tutorial material may vary slightly from that depicted here.

Week	Date	Lecture	Topic	This week
1	Th Sept 8	1	<i>Welcome to Principles of Biomechanics</i> What is Biomechanics? Basics of Human Anatomy	Practice Problems: PB Set #1 Practice Problems: PB Set #2
2	Tu Sept 13	2	Forces/Moments in the human body Newtonian Mechanics; Right Hand Rule	Practice Problems: PB Set #3
2	Th Sept 15	3	Free body diagrams: Overview & Sample Problems; Vector addition	Practice Problems: PB Set #3
3	Tu Sept 20	4	Net Joint Forces & Moments Rule	Tutorial Activity #1 - Free Body Diagrams (FBDs)
3	Th Sept 22	5	Calculating $F = ma$ when moment arm is unknown; Lever Arms	Tutorial Activity #1 - Free Body Diagrams (FBDs)
4	Tu Sept 27	6	Complex FBD; Net joint moment and relationship to muscle force Forces	Practice Problems: PB Set #4
4	Th Sept 29	7	Bone on Bone Forces Link Segment Modelling	Practice Problems: PB Set #4
5	Tu Oct 4	8	Linear Kinematics; Projectile Motion	Practice Problems: PB Set #5
5	Th Oct 6	8	Angular Kinematics; Joint Angles	Practice Problems: PB Set #5
	Tu Oct 11		Study BREAK –no lecture	
6	Th Oct 13	9	Review (if needed); Anthropometrics	Practice Problems: PB Set #6
7	Tu Oct 18	10	MID-TERM in class	Mid-Term content: Lec. 1-8; PB Sets 1 to 5
7	Th Oct 20	11	Muscle Mechanics	Practice Problems: PB Set #6
8	Tu Oct 25	12	Electromyography	Practice Problems: PB Set #7

Week	Date	Lecture	Topic	This week
8	Th Oct 27	13	Force-Length & Force Velocity Relationships	Practice Problems: PB Set #7
9	Tu Nov 1	14	Tissue Properties	Tutorial Activity #2: Problem Sets 6, 7
9	Th Nov 3	15	Injury Mechanics Case study: Plyometrics	Tutorial Activity #2: Problem Sets 6, 7
10	Tu Nov 8	16	Kinetics: Moment of Inertia	Practice Problems: PB Set #8
10	Th Nov 10	17	Kinetics: Moment of Inertia	Practice Problems: PB Set #8
11	Tu Nov 15	18	Linear Impulse & Momentum	Practice Problems: PB Set #9
11	Th Nov 17	19	Rotational Impulse & Momentum Conservation of Momentum	Practice Problems: PB Set #9
12	Tu Nov 22	20	Work/Energy and Power	Tutorial Activity #3: Problem Sets 8, 9
12	Th Nov 24	21	Dynamic Equilibrium	Tutorial Activity #3: Problem Sets 8, 9
13	Tu Nov 29	22	Segmental Energy/Efficiency	Review of all Course Material
13	Th Dec 1	23	Wrapping it up and Review	Review of all Course Material

Final Exam Saturday December 10th – 08:30 AM to 10:30 AM [Location to be Announced]

Methods of Evaluation (all closed book):

<u>Form of Assessment</u>	<u>Weight of Assessment</u>	<u>Due Date of Assessment</u>	<u>Location</u>
Tutorial Activities – 3 in total	Total weight 12%; <i>each activity is worth 4%</i>	1 – Sept 21 or 22 2 – Nov 2 or 3 3 – Nov 23 or 24	In regular tutorial section
Midterm Exam	33%	Tuesday October 18 th , 10 - 11:20 am	ROZH 103
Final Exam, cumulative	55%	Saturday Dec 10 th , 8:30 am – 10:30 am	TBA

Description of Assessment

ALL tutorial activities, mid-term and final examinations are **mandatory**. Please inform the instructor of potential time conflicts with scheduled evaluations by **Thursday September 15, 2015**. All evaluation methods will count toward the calculation of your final grade in the course. If any scheduled evaluations are missed due to documented illness or compassionate circumstances, you must inform an instructor within 5 days of the missed evaluation. Negligence to do so may result in failure of the missed component. Accommodations following these circumstances will be made at the discretion of the course instructor. If a student has any objections or concerns regarding the way a course component has been graded, they may resubmit this component for re-marking; the risk, however, is that this re-evaluation will remain the final one, whether higher or lower in score than the original.

Practice Problems are assigned on a weekly basis; it is expected that students will attempt all problems prior to attending weekly tutorial sessions.

Tutorial Activities will test concepts taught in lecture and in assigned problem sets and **must be completed in the tutorial session**; a zero mark will be recorded for any Tutorial Activity not handed in for grading. **Please note** that all announcements, problem sets and course updates will be posted on the Courselink site.

Tutorial sessions will be used throughout the semester to take up questions from assigned problem sets, tackle new problems in break-out groups and periodically for **marked Tutorial Activities** that will test concepts taught in lecture and in assigned problem sets. These Tutorial Activities **must be completed in the tutorial session**. It is expected that students will have attempted questions from the assigned problem sets prior to each weekly tutorial session.

COURSE AND UNIVERSITY POLICIES

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact, and be prepared to provide supporting documentation. See the Undergraduate Calendar for information on regulations and procedures for Academic Consideration.

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Student Accessibility Services (SAS) as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the [SAS website](#)

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submission. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The [Academic Misconduct Policy](#) is detailed in the Undergraduate Calendar.

Email Communication

As per university regulations, all students are required to check their <uoguelph.ca> email account regularly: email is the official route of communication between the University and its students. Also please note, email questions that can be easily answered by looking at the course outline information or material posted on CourseLink, will not be answered.

Drop Date

The last date to drop one semester Fall 2016 courses, without academic penalty, is November 4, 2016. For regulations and procedures for [Dropping Courses](#), see the Undergraduate Calendar.

Copies of out-of-class-assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

CAMPUS RESOURCES

The [Undergraduate Calendar](#) is the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:

If you are concerned about any aspect of your academic program:

Make an appointment with a [Program Counsellor](#) in your degree program.

If you are struggling to succeed academically:

There are numerous academic resources offered by the [Learning Commons](#) including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.

If you are struggling with personal or health issues:

[Counselling services](#) offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.

[Student Health Services](#) is located on campus and is available to provide medical attention.

For support related to stress and anxiety, besides Health Services and Counselling Services, [Kathy Somers](#) runs training workshops and one-on-one sessions related to stress management and high performance situations.

If you have a documented disability or think you may have a disability:

The [Student Accessibility Services](#) (SAS) can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability.