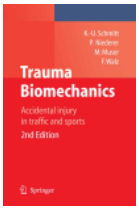
MECH 436/536: Fundamentals of Injury Biomechanics

2015-2016 – Term 2
Class Time: Monday, Wednesday, and Friday 4:00 PM to 5:00 PM
Class Location: MacLeod 202
Tutorial Time: Monday, 5:00 PM to 6:00 PM
Tutorial Location: FSC 1003
Prerequisites: Mech 360 and Mech 364, or approval of the instructor
Course material posted on Connect (www.connect.ubc.ca)

Instructor: Agnes d'Entremont, PhD (KAIS 1132, agnes.dentremont@mech.ubc.ca)
Office Hours: By appointment
Communication:
Email communication is welcome. Please put "MECH 436/536" in the subject, so your message gets filtered appropriately. You can expect a reply within 24 hours on weekdays; in general, don't expect a reply on the weekend, although brief answers may be supplied. If the answer to your question will take more than a paragraph, we probably should discuss it in person - please drop by and see me!

TA: TBA

Required text: Trauma Biomechanics, (4th Edition) Accidental Injury in Traffic and Sports, Springer Verlag, Berlin, 2014 (Available as an ebook through UBC library)



Graphic content:

This course discusses mild and severe injuries, accidents (such as car-pedestrian impacts or head-first impacts), cadaver testing, animal testing, and other topics. Material shown in class may include photographs and videos of accident scenes, injuries, experimental devices to replicate injury or accidents, animal testing, cadavers, etc. On site visits, you may see experimental devices designed to replicate injury or accidents, human and animal cadaveric specimens and whole human cadavers. This list may not be exhaustive. It will not be possible to avoid such material in the class and assignment work.

Some people can have physical reactions to such material, including fainting (vasovagal response). If at any time you feel faint, sit or lie down immediately and let someone know. Your safety is important.

Course Description[1]

Biomechanics is the application of the principles of mechanics in the analysis of biological systems. The field of injury biomechanics, which is also called impact biomechanics or trauma biomechanics, is focused on understanding the behaviour of human beings and our organs, bones and other tissues at the point of mechanical or functional failure which corresponds to injury. The applications of injury biomechanics are numerous and it is the discipline centrally involved in the conception and development of devices we think of as "safety equipment" such as:

- Automotive Restraints – *What are the functional requirements of seat belts and airbags?*
- Automotive Design – *How should a vehicle be best designed to mitigate injury to a pedestrian?*
- Sports Equipment – *How thick should gymnastics mats be? How deep should the pool be for racing starts at a swim meet?*
- Helmets – *How should a bicycle helmet differ from a hockey helmet and why?*

[1] Course description from Dr. Peter Cripton

Injury biomechanics is also central to improving our understanding of human injury mechanisms when this is necessary to enable novel clinical treatments to be developed. For example: *What are the strain rates within the various tissues of the brain during an impact to the head causing a concussion?*

This course provides the student an overview of the fundamental concepts and techniques that are presently in use in this field and the tolerance of various human systems to injury. The course is arranged in three learning units:

1. **Methods in Injury Biomechanics**

   In the first unit of the course we will focus on background information and on the tools used in this field including an overview of anatomy, loading apparatus and high-speed instrumentation necessary for impact experiments, public databases for use in determining injury rates in the population and this data's application to impact biomechanics research, anthropomorphic test devices (crash test dummies), use of radiological (x-ray, CT, MRI) data sources for injury analysis, multi-body dynamic and finite element mathematical models and cadaver/animal models used for injury biomechanics research.

2. **Injury Tolerance**

   In the second unit of the course we will focus on the state of knowledge regarding injuries in particular regions or tissues of the body. One central theme here will be the current understanding of the injury tolerance of various materials (i.e. bones, or tissues that make up the brain) and structures (i.e. the bone of the upper leg, discs of the spine, and the brain). Injury tolerance refers to the point at which the material or structure fails and it is analogous in solid mechanics to the yield stress or to the ultimate stress of a material. In this section we will examine the tolerance of the main structures and materials of the head, brain, spine, thorax, abdomen, pelvis and extremities.

3. **Injury Prevention**

   In the third unit we will study devices and approaches that are focused on prevention of injury. These devices are those you might presently think of as "safety equipment" including helmets, airbags, seatbelts, headrests and active "whiplash" prevention seats and automotive designs and devices that reduce the severity of a pedestrian impact.

The course will stress application of the course content to real-world problems in this area. There will also be a strong focus on the use and critical appraisal of current injury biomechanics literature. Course assessment will consist of several assignments taken from real world injury scenarios, a literature review, a midterm and a final in the course.

Tentative schedule:

Week	Lecture Topic	Time
	1. Methods in Injury Biomechanics	
1	Intro to Injury Biomech and Instruments Instruments and Experiments	3 hr
2	Instruments and Experiments ATDs and PMHS	3 hr
3	ATDs Sled and Crash Testing	3 hr
4	Sled and Crash Testing Automotive Reconstruction Math models	3 hr
5	Injury Criteria – IARV, AIS Databases – NHTSA/CIREN Use of medical records	3 hr
6	Mid-term Exam	
	2. Injury Tolerance	
8	Head / Brain	3 hr

9	Spine / Spinal Cord	3 hr
10	Thorax/Abdomen	1 hr
11	Pelvis/Extremity	2 hr
	3. Injury Prevention	
11	Rollover	1 hr
12	Head/Helmet/Bicycle Seatbelt	3 hr
13	Airbag/Seat Belt	3 hr
14	Infrastructure/Sports	3 hr
	Final Exam	

Important dates

Literature review partners – January 15, 2016
Literature review proposal – February 5, 2016
Midterm exam – February 12, 2016
Literature review presentations – Mar 7 – Mar 21, 2016
Project presentations – April 8, 2016

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences[2].
http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0

As engineering students, you should also follow the APEGBC Code of Ethics.
https://www.apeg.bc.ca/For-Members/Ethics,-Law-and-Conduct#APEGBCCodeofEthics

Please be sure to credit all contributions appropriately. If you are unclear as to the correct course of action for a particular situation, please ask **before** handing in work.

For assignments, students are free to collaborate on understanding the problem, problem-solving approaches, and conceptual solutions, but be sure to analyze/write up your answers independently. Students are not permitted to utilize course material from previous years in completing their assignments. The minimum penalty for plagiarism in any assignment is a zero for the assignment; additional disciplinary measures may be determined by the University, including a zero in the course, suspension, a permanent notation of misconduct on your academic record, and/or expulsion.

Submitted work

Written work should be legible (if hand-written and/or scanned or photographed to send electronically), and should be reasonably correct in mechanics (e.g. spelling, grammar, punctuation, etc.). Gender-neutral language is required. Grading will take these factors into account. Assistance with general writing mechanics is available through UBC.
http://learningcommons.ubc.ca/tutoring-studying/improve-your-writing/

As part of appropriately crediting contributions, if you have had assistance with a specific piece of work (whether through the UBC Writing Centre or elsewhere), please acknowledge the person/organization from whom you obtained

[2] From Dean's Office, Applied Science

assistance and the type of assistance you obtained in the document you submit. (If you are not sure how to do this, please ask me).

Please submit assignments, papers, etc. as PDFs rather than Word or Excel documents. This will help ensure that your formatting will not change for the worse on the receiving end.

If you have not started already, I suggest you use a bibliographic management package to create citations and bibliographies in your written work. Mendeley (free) is recommended; you can import citations from PDF files and websites, keep papers linked to citations and notes, and use with Word for inserting and formatting citations. Zotero (also free) is another option. UBC also provides RefWorks for all students through the library (does not manage PDFs).

Grading

Grading distribution

Evaluation method	436 Undergrad %	536 Grad %
1. Midterm exam	20	15
2. Final exam	40	25
3. Literature Review Presentation *See information on Connect for Literature Review Presentation grade breakdown*	20	20
4. Assignments *Assignments, 1-5 equally weighted, 6=2x 90%* *In class activities, equally weighted, 10%*	20	15
5. Project (536 only) *See information on Connect for project grade breakdown (to be posted)*	-	25
Total	100	100

Instructors and TAs require a minimum of two weeks to mark assignments. Students must pass the weighted, combined examinations to pass the course.

Due dates:

All submitted work (except for the Literature Review Presentation slides and bibliography) will be due by the end of the calendar day (i.e. by 11:59 pm on the date due, via Connect timestamp). Additional days taken beyond the original due date will also be counted up until 11:59 pm. Literature Review Presentation slides and bibliography will be due on Connect four hours before the start of the session you are scheduled to present in.

Assignments received after the due date will receive a maximum mark of 85% at due date +1 day, 70% at due date +2 days, 55% at due date +3 days. Assignments received four or more days after the due date will be corrected for feedback purposes, but will receive a mark of zero.

In class activities may include group work to be handed in or presented. Material will be handed in at the end of class.

Other important information

Attendance:

Students are expected to attend all classes in which they are enrolled, unless an academic concession has been granted. It is the student's responsibility to determine what material or announcements they may have missed (from other students and/or Connect; note that asking the instructor to provide the information again may not be a viable method).

Missing classes, exams or deadlines for a valid reason (academic concession) will be evaluated on a case-by-case basis. http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,48,0,0

Tutorials:
Attendance at tutorials sessions is required. Tutorial sessions will be used for a mix of purposes, including to cover course material, for student presentations, and for practice problems, etc.

Recording of classes:
Due to the use of confidential material (made available for limited learning purposes only) and copyrighted material in teaching this class, students are not permitted to take photos or make audio and/or video recordings of class without explicit permission of the instructor and/or guest lecturer(s)/speaker(s). If you require a recording of the lecture due to a disability, please contact UBC Access and Diversity about an accommodation. Students are not permitted to electronically capture other students' work without the explicit permission of the student author.

Site visits:
Site visits are not mandatory, but will be great learning opportunities. See specific information on Connect.

Student accident insurance:
Students are not covered by WorkSafeBC for accidents or injuries resulting from class-related activity. As class activities, site visits and projects will involve going into active experimental and anatomy labs, please make sure your insurance in up-to-date.

Expectations[3]:
You can expect me to:

- Start and end class on time
- Reply to e-mails within 24 hours on weekdays
- Assign work that adequately covers the material and meets the learning objectives of the course while adhering to the time expectations for a 3-credit 400/500 level course
- Give exams that accurately reflect the material covered in class and assigned in homework

I can expect you to:

- Come to class on time
- Be attentive and engaged in class
- Refrain from using electronic devices for non-related activities during class
- Spend an adequate amount of time on the assignments, making an effort to solve and understand each problem
- Engage with both the abstract and analytical sides of the material
- Seek help when appropriate

We will both be expected to[4]:

- Conduct ourselves with fairness, courtesy, and good faith towards colleagues and others
- Give credit where it is due
- Accept and give honest and fair professional comment

Note: Changes may be made to this syllabus without notice as required – check course announcements regularly.

[3] Modified from Dr. Andrew Beveridge, Carnegie Mellon University
[4] Modified from APEGBC Code of Ethics