

# MECH 436/536

## Fundamentals of Injury Biomechanics

2010-2011 – Term 2

**Class Time:** Monday Wednesday and Friday 3:00 PM to 4:00 PM

**Class Place:** Frank Forward 317

**Tutorial Time:** Wednesday at 10:00 AM **Tutorial Place:** CEME 1212

**Prerequisites:** Mech 360 and Mech 364 or approval of the instructor

**Instructor:** Peter A. Cripton, Ph.D. P.Eng. (CEME 2063, [cripton@mech.ubc.ca](mailto:cripton@mech.ubc.ca), )

**Office Hours:** Arrange by Email

**Course Description:** 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?*

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.

The course schedule and grading scheme is indicated below:

### **MECH 436/536 - Schedule:**

<b><i>Wk</i></b>	<b><i>Lecture Topic</i></b>	<b><i>Time</i></b>
	<b><u>1. Tools used for Injury Biomechanics</u></b>	
1	Intro to Injury Biomech and Instruments	3 hr
2	ATDs	3 hr
3	Sled and Crash Testing	3 hr
4	Automotive Reconstruction	3 hr
5	Injury Criteria – IARV, AIS	3 hr
	<b><u>2. Injury Tolerance</u></b>	
6	Head / Brain	3 hr

7	Spine / Spinal Cord	3 hr
	<b>Mid-term Exam</b>	
8	Thorax/Abdomen	3 hr
9	Pelvis/Extremity	3 hr
	<b><u>3. Injury Prevention</u></b>	
10	Pedestrian	3 hr
11	Head/Helmet	3 hr
12	Airbag/Seat Belt	3 hr
13	Whiplash / Review	3 hr
	<b>Final Exam</b>	

**MECH436/536 - Grading Scheme:**

Evaluation method	Undergrad%	Grad%
1. Midterm	20	15
2. Final	40	25
3. Lit review/Journal critique	20	25
4. Assignments	20	15
5. Project		20

**Mech 536 Journal Club: Thursdays at 3:30 PM-4:30 PM at the Blusson Spinal Cord Centre lecture hall (ground floor at 818 West 10<sup>th</sup> Ave, Vancouver General Hospital campus).** Mech 536 students are required to attend, participate and present at a weekly journal club that is also attended by graduate students of the Orthopaedic and Injury Biomechanics Group and by students of Mech 535 – Orthopaedic Biomechanics.