

**APA 4314**  
**Biomechanical Analysis of Physical Activity**  
**Fall 2010**

---

**Instructor:** Prof. Gordon Robertson, PhD, FCSB, Montpetit 343  
613-562-5800 ext.4253 (office), ext.4246 (lab), E-mail: [dger@uOttawa.ca](mailto:dger@uOttawa.ca)  
Website: <http://www.health.uottawa.ca/biomech/courses/apa4311>

**Course Objectives:**

To apply scientific principles and techniques to measure and to analyze the biomechanical characteristics of human motion in particular locomotion. This objective will be realized through lecture and laboratory study and the experience of conducting a group research project. Students will present the results of their research orally and in written form.

---

**Course Evaluation:**

Labs:	25%
Midterm exam	10%
Project: oral	10%
written	30%
Final and lab exam:	25%

---

**Required Text:**

**Robertson, D.G.E.; Caldwell, G.E.; Hamill, J.; Kamen, G. and Whittlesey, S.N. (2004)**  
***Research Methods for Biomechanics*. Champaign: Human Kinetics Publishers.**

**Optional Texts:**

Chapman, A.E. (2008) *Biomechanical Analysis of Fundamental Human Movements*. Champaign, IL: Human Kinetics Publishers.

Kirtley, C. (2006) *Clinical Gait Analysis*. Toronto: Churchill Livingstone.

Nigg, B.M. & Herzog, W. (1994) *Biomechanics of the Musculo-skeletal System*. Toronto: John Wiley & Sons.

Whittle, M.W. (2001) *Gait Analysis: An Introduction. Third edition*. Oxford: Butterworth Heinemann.

Winter, D.A. (1991) *Biomechanics and Motor Control of Human Gait: Normal, Elderly and Pathological. Second Edition*. Waterloo: Waterloo Biomechanics.

Winter, D.A. (2005) *Biomechanics and Motor Control of Human Movement. Third Edition*. Hoboken, NJ: John Wiley & Sons.

---

## Course Content:

### Kinematics:

- Direct kinematic methods
- Imaging techniques
- Data conversion and data smoothing
- Angular kinematics

### Body Segment Parameters:

- Segmental masses and centres of gravity
- Segmental radii of gyration and moments of inertia
- Total body parameters

### Kinetics:

- Dynamometry
- Impulse and momentum
- n-Link systems of rigid bodies
- Inverse dynamics
- Work, energy and power
- Intersegmental power analysis
- Joint power analysis

### Electromyographic Kinesiology:

- Neuromuscular physiology of muscle contraction
- Electromyography: recording
- Electromyography: processing
- Relationships between EMG and mechanical variables

---

## Reading List:

Pezzack, J.C.; Winter, D.A. & Norman, R.W. (1977) An assessment of derivative determining techniques used for motion analysis. *Journal of Biomechanics*, 10:377-382.

Robertson, D.G.E. and Dowling J.J. (2003) Design and responses of Butterworth and critically damped digital filters. *Journal of Electromyography and Kinesiology*, 13(6):569-573.

Robertson, D.G.E. & Winter D.A. (1980) Mechanical energy generation, absorption and transfer amongst segments during walking. *Journal of Biomechanics*, 13:845-854.

Winter, D.A. (1976) Analysis of instantaneous energy of normal gait. *Journal of Biomechanics*, 9:253-257.

Winter, D.A. (1980) Overall principle of lower limb support during stance phase of gait. *Journal of Biomechanics*, 13:923-927.

Winter, D.A. & Robertson, D.G.E. (1978) Joint torque and energy patterns in normal gait. *Biological Cybernetics*, 29:137-142.

---

## Laboratory Schedule:

1. **Frequency Analysis of Signals**  
Fourier series, harmonic analysis, Fast Fourier Transform (FFT) BioProc2 Fourier series reconstruction
2. **Data Smoothing**  
Moving average  
RMS Digital  
filtering
3. **Vicon Motion Capture**  
Vicon Workstation/Nexus  
uOttawa Marker Set
4. **Visual3D Motion Analysis**  
Body segment parameters  
Modelling
5. **Force Platform Analysis (Kistler)**  
Force histories, centre of pressure paths and force vectors Impulse analysis and impact analysis
6. **Gait Analysis**  
Gait characteristics  
Mechanical Energy Analysis
7. **Inverse Dynamics**  
Net moments and forces  
Moment power analysis
8. **Electromyography: Isometric Contractions**  
Electrode placement  
Analog data processing (rectification, linear envelope, integration)
9. **Electromyographic Kinesiology: Dynamic Contractions**  
Digital data processing and analysis using BioProc2 Frequency analysis Fatigue analysis Cumulative Amplitude Probability Distribution Function (CAPDF)