Instructor: Peter Keir  pjkeir@mcmaster.ca, IWC212, x23543

This course is designed to expose students to methods and instruments used to collect and process data in Kinesiology research. The goal of this course is to: 1) prepare you for conducting research with advanced methodologies and 2) increase your understanding of the methods used in the scientific literature in the areas of biomechanics, neuroscience, ergonomics, exercise physiology, and related areas. Students will be presented with lecture material, will participate in seminars and will complete independent projects.

Course Evaluation

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Assignment(s)</td>
<td>15%</td>
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<tr>
<td>Term Exam</td>
<td>25%</td>
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<tr>
<td>Review Paper</td>
<td>35%</td>
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<tr>
<td>Presentation</td>
<td>15%</td>
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<tr>
<td>Participation/weekly paper discussion</td>
<td>10%</td>
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1. Course Introduction:

2. Numerical Methods and Transducers in Biomechanics
   - analog-to-digital conversion
     - frequency and amplitude resolution
   - the nature of signals:
     - amplitude and frequency domain
     - Fourier analysis
   - zero/first/second order mechanical systems
     - mass/spring/damper systems
     - stiffness, damping, damping ratios, natural frequency
     - system responses: impulse, step, ramp, characterizing responses
   - electronics and transducers
     - electric circuits (resistors, capacitors, parallel and series circuits)
     - transducers (strain gauges, accelerometers, force plates, potentiometers, amplifiers etc)
   - signal-to-noise optimization
     - digital filters

3. Muscle Physiology, Mechanics and Electromyography
   - muscle contraction
     - neuromuscular system
     - motor units and their action potentials
     - muscle force-length and force-velocity characteristics
   - electromyography (EMG) signal recording
     - electrode types and signal characteristics, signal amplification, amplifier specifications
     - EMG-Force relationship
       - signal processing, muscle force modeling, integration of muscle mechanics, limitations
     - EMG-Fatigue relationships
       - physiological mechanisms, signal processing
4. 3D Kinematics
   - scalars, 3D Vectors, Matrices
   - collection of 3D kinematic data
     - local vs global coordinate systems
     - marker systems
   - Cardan/Euler angles
   - Joint Coordinate System (JCS: Grood & Suntay technique)

5. Biomechanical Modeling
   - muscle architecture
   - musculoskeletal anatomy and geometry (origin/insertion models)
   - muscle forces estimation models
     - single equivalent
     - optimization
     - EMG-based
   - tissue modelling

**PLEASE NOTE:**

On occasion, it is difficult to predict the direction the course may take and the instructor may need to revise the course outline during term. Students will be informed as early as possible of any changes.

The Department of Kinesiology reserves the right to change dates, deadlines, and/or methods of assessment for this course in the event of unforeseen circumstances, such as illness of the instructor or a labour disruption.

**ACADEMIC INTEGRITY**

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences (e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript reading "Grade of F assigned for academic dishonesty", and/or suspension or expulsion from the university). It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at: [http://www.mcmaster.ca/univsec/policy/AcademicIntegrity.pdf](http://www.mcmaster.ca/univsec/policy/AcademicIntegrity.pdf)

The following illustrates only three forms of academic dishonesty:
* Plagiarism (e.g. the submission of work that is not one's own or for which other credit has been obtained),
* Improper collaboration in group work.
* Copying or using unauthorized aids in tests and examinations.
<table>
<thead>
<tr>
<th>Wk #</th>
<th>Dates</th>
<th>Topic</th>
<th>Readings &amp; Assignments (readings to be added)</th>
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<tbody>
<tr>
<td>1</td>
<td>W Sept 13</td>
<td>Intro, Biomech Review</td>
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<tr>
<td>2</td>
<td>W Sept 20</td>
<td>Signals &amp; EMG Basics</td>
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<td>3</td>
<td>W Sept 27</td>
<td>A/D</td>
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<td>4</td>
<td>W Oct 4</td>
<td>The Measurement System</td>
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<td>5</td>
<td>W Oct 11</td>
<td>Mechanical systems/ Fourier</td>
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<td>6</td>
<td>W Oct 18</td>
<td>Digital Methods</td>
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<td>7</td>
<td>W Oct 25</td>
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<td>8</td>
<td>W Nov 1</td>
<td>Muscle, EMG – Force, Fatigue</td>
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<td>9</td>
<td>W Nov 8</td>
<td>More EMG methods</td>
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<td>10</td>
<td>W Nov 15</td>
<td>Motion Capture</td>
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<td>11</td>
<td>W Nov 22</td>
<td>3D Kinematics</td>
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<td>12</td>
<td>W Nov 29</td>
<td>TERM EXAM (2 hours)</td>
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<td>13</td>
<td>W Dec 6</td>
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<td>14</td>
<td>W Dec 13</td>
<td>Final Presentations (Paper due)</td>
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