Course Outline

Program: Kinesiology
Course #: KIN 500, Section 001

Term/Year: Sept – Dec 2022
Course Title: Introduction to data acquisition and signal processing in Kinesiology
Location(s): Osborne Gym G (125G2)

Day/Time: Thursday, 9h-12h
Instructor: Jean-Sébastien Blouin
Phone: 604-827-3372
Email: jsblouin@mail.ubc.ca

Course Site: https://canvas.ubc.ca/

Course Description:

The focus of this course is to provide graduate students with the practical experience necessary for the acquisition and processing of data related to human movements. This course will cover modern approaches and techniques commonly used for wearable sensing and laboratory research applicable to diverse disciplines related to Kinesiology, including biomechanics, physiology, neuroscience, psychology, and motor learning. These approaches and techniques include (but are not limited to) sampling theory, acquisition of analog and digital data with wearable and laboratory-grade instruments, synchronization of data from multiple sources, analog and digital filters as well as common data analysis methods. It is assumed that students have an undergraduate background in Kinesiology or related field as well as basic linear algebra and computer skills. Emphasis is placed on hands-on laboratory skills, presentation skills and on the methodological aspects underlying the development of a research project.

Objectives:

1. Learn the fundamental theory, tools and approaches to acquire and process data associated with human movements.
2. Formalise and present conceptual ideas, methodological approaches and results on data acquisition/signal processing topics related to human movements.
3. Evaluate the application of data acquisition and processing approaches to specific situations and provide feedback to peers.
4. Develop and perform a research project for an in-depth learning of specific topics discussed in class related to the students’ research interest.

Expectations:

Students are required to perform weekly laboratory activities and/or presentations on topics discussed in class. In addition, they need to prepare for the material to be discussed in the roundtable discussions through proposed readings.
Course Evaluation:

A. Weekly or bi-weekly presentations: 30%

Students will lead a 4-minute presentation on the data acquisition/processing approaches and techniques learned during the preceding week. During the term, students are encouraged to use at least once a less familiar software for data analysis (Matlab, Python, R, Julia or LabVIEW).

An important emphasis is placed on data visualization & illustration of the main concepts. Students are encouraged to use LibreOffice, GSuite or Powerpoint.

B. Leading weekly or bi-weekly seminars: 20%

Students will lead class discussions at least once during the term. These presentations will be performed in teams. They will be in charge of:

- Presenting the main topics they were assigned for the week (30-45 mins),
- Highlighting 3 to 5 important concepts to discuss with the group (the use of creative figures and videos is encouraged),
- Lead a discussion on potential limitations/issues related to the readings

C. Presentation of Research Project: 40%

Date to be determined. A 15-minute oral presentation of their research project. Students will present their research project with a major emphasis on the data acquisition requirements and signal processing approaches necessary for interpreting the data.

An important emphasis is placed on data visualization & illustration of the main concepts. Students are encouraged to use LibreOffice, GSuite or Powerpoint.

C. Class participation: 10%

Active class participation is required for the good functioning of the course. Students will be graded based on their preparation of the assigned material and participation to in-class roundtable discussions.

This course is centered around the students' interests and human movement data acquisition/processing needs. Consequently, students will be able to use the equipment in their research lab as well as wearable or laboratory-grade instrumentation available in the School of Kinesiology Learning Centre for the hands-on component. Although we will cover the theory underlying data acquisition and analysis, we will focus on the applications of key data acquisition and analysis concepts critical for applications involving human movements.
Readings:

Readings will consist of book chapters and original research articles from peer-reviewed journals.

Each week, students will be assigned a set of readings. These readings are intended to provide a background overview of the themes and concepts and must be read in preparation for the seminars. Students will facilitate a roundtable discussion and presentation of the topics covered in the assigned readings.

For week 1, students must bring to class a paper that uses a signal processing technique or describe a data-related problem they intend to learn in this course.

Sample list of recommended readings (more may be added throughout the course as appropriate):

- Smith, SW. The Scientist and Engineer’s Guide to Digital Signal Processing
  http://www.dspguide.com/pdfbook.htm

  https://www.youtube.com/channel/UC8owx2vNE7XVrjMOCUgZkAA/videos


- LabVIEW Manuals and Help Guides

- Matlab Manuals and Help Guides

- Python Books, Help Guides and Tutorials
  https://wiki.python.org/moin/BeginnersGuide
  https://greenteapress.com/wp/think-python-2e/
  https://greenteapress.com/wp/think-dsp/

- Bendat JS, Piersol AG. Random data analysis and measurement procedures (3rd Ed). Wiley. 2000. 594 pages


- Winter DA. Biomechanics and Motor Control of Human Movement. Wiley. 2009. 384 pages

- Merfeld DM. Signal detection theory and vestibular thresholds: I. Basic theory and practical considerations. Exp


## Schedule

### Week 1

**Course Introduction**
Brief introduction. Presentation of software relevant for data analysis and presentation. Students present a paper that uses a signal processing technique or describe a data-related problem they intend to learn from this course.

### Week 2

**Signal Processing overview and Introduction to Matlab, Python, R & LabVIEW**
Readings:
- [https://www.youtube.com/watch?v=7bnVx34yQf4](https://www.youtube.com/watch?v=7bnVx34yQf4)

### Week 3

**Sampling a continuous time signal and Introduction to analog & digital signals using wearable or laboratory-grade instruments**
Readings:
- Van Drongelen W. Signal Processing for Neuroscientists. An introduction to the analysis of physiological signals. Chap 1 & 2 (see online lectures: [https://www.youtube.com/channel/UC8owx2vNE7XvriMOCUgZkAA/videos](https://www.youtube.com/channel/UC8owx2vNE7XvriMOCUgZkAA/videos))

**Matlab & Arduino**
- [https://www.youtube.com/c/ArduinoRoboticsLabVIEWSolidworks/search?query=matlab%20arduino](https://www.youtube.com/c/ArduinoRoboticsLabVIEWSolidworks/search?query=matlab%20arduino)
- [https://www.youtube.com/watch?v=8NQ1h0gGgX8](https://www.youtube.com/watch?v=8NQ1h0gGgX8)
- [https://www.youtube.com/watch?v=nOz3uTi20Jo](https://www.youtube.com/watch?v=nOz3uTi20Jo)

**LabVIEW**

### Week 4

**Preliminary findings, Tutorial & Discussions on Sampling a continuous time signal and Introduction to analog & digital signals.**

### Week 5

**Synchronization of data from different sources using wearable and/or laboratory-grade instruments**
Readings:
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<tr>
<th>Week 6</th>
<th>Data analysis, noise &amp; signal averaging</th>
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<td>Readings:</td>
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<tr>
<th>Week 7</th>
<th>Continuous, discrete and Fast Fourier Transform. Brief overview of correlation in the time and frequency domains.</th>
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<td>Readings (recommended to read in order):</td>
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<tr>
<td></td>
<td>Smith, SW. The Scientist and Engineer’s Guide to Digital Signal Processing. Chap 5-6-8-9-10 &amp; 12.</td>
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<tr>
<td></td>
<td>Van Drongelen W. Signal Processing for Neuroscientists. An introduction to the analysis of physiological signals. Chap 5, 6, 7 &amp; 8 (see online lectures: <a href="https://www.youtube.com/channel/UC8owx2vNE7XVriMOCUgZkAA/videos">https://www.youtube.com/channel/UC8owx2vNE7XVriMOCUgZkAA/videos</a>)</td>
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| Week 8 | Preliminary findings, Tutorial & Discussions on Continuous, discrete and Fast Fourier Transform |

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<th>Week 9</th>
<th>Introduction to filters &amp; filter analysis: The RC circuit</th>
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<td>Readings:</td>
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<tr>
<td></td>
<td>Van Drongelen W. Signal Processing for Neuroscientists. An introduction to the analysis of physiological signals. Chap 10, 11, 12 (see online lectures: <a href="https://www.youtube.com/channel/UC8owx2vNE7XVriMOCUgZkAA/videos">https://www.youtube.com/channel/UC8owx2vNE7XVriMOCUgZkAA/videos</a>)</td>
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<tr>
<td></td>
<td>Smith, SW. The Scientist and Engineer’s Guide to Digital Signal Processing. Chap 3 (pp 48-58)</td>
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<tr>
<th>Week 10</th>
<th>Introduction to filters &amp; filter analysis: Digital filters</th>
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<td></td>
<td>Van Drongelen W. Signal Processing for Neuroscientists. An introduction to the analysis of physiological signals. Chap 13 (see online lectures: <a href="https://www.youtube.com/channel/UC8owx2vNE7XVriMOCUgZkAA/videos">https://www.youtube.com/channel/UC8owx2vNE7XVriMOCUgZkAA/videos</a>)</td>
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| Week 11 | Preliminary findings, Tutorial & Discussions on Introduction to filters & filter analysis: Digital filters |

| Week 12 | Research Project |

| Week 13 | Research Project |

| Week 14 | Research Project Presentations |