HHNS*6810 Research Methods in Integrative Biomechanics and Neurophysiology I

Fall 2020
Section(s): 0101

Department of Human Health and Nutritional Sciences
Credit Weight: 0.50
Version 1.00 - September 08, 2020

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1 Course Details

1.1 Calendar Description

This course develops a comprehensive understanding of methods and analysis related to research in biomechanics & neuroscience. Critical evaluation and application of basic signal to noise processing and electromyography is a priority. The course uses labs, assignments, and critical review of primary literature articles to develop a strong research foundation. Scientific writing and oral communication skills are emphasized via written reports and presentations, and numeracy throughout the course in data and lab assignments.

1.2 Course Description

This course develops a comprehensive understanding of methods and analysis related to research in biomechanics & neuroscience. The course uses labs, assignments, and critical review of primary literature articles to develop a strong research foundation. Critical evaluation and application of research methods is a priority. Scientific writing and oral communication skills are emphasized via written reports and presentations, and numeracy throughout the course in data and lab assignments.

1.3 Timetable

Lecture Schedule: Friday 9:00 am - 12:50 pm; SSC1304 (likely a remote and in person hybrid for delivery)

Lab Schedule: Mondays 9:00 am - 12:00 pm, Labs will be run remotely. This time period must be reserved.

Office hours: i.e. Once a week through TEAMS. This will occur for 1.5 hours during the regularly scheduled lab session on Mondays 9:30-11:00

1.4 Final Exam

time and place t.b.a.

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2 Instructional Support

2.1 Instructional Support Team

Instructor:	Leah Bent
Email:	lbent@uoguelph.ca
Telephone:	+1-519-824-4120 x56442
Office:	ANNU 331
Office Hours:	by appointment
Instructor:	Steve Brown
Email:	shmbrown@uoguelph.ca
Office Hours:	by appointment

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3 Learning Resources

3.1 Recommended Resources

Resources (Article)

Guidelines to Help Focus Reading of Scientific Papers

The following are some guidelines to keep in mind while reading scientific publications.

1. What was the reason for doing the work in the first place?
2. Was the question posed in a researchable way?

3. What was being measured?
4. Was the measure appropriate to answer #1?
5. How was it measured?
6. Was the measurement technique suitable?
7. Were there any assumptions or errors (implicit or explicit) that might nullify any conclusions drawn?
8. What were the main useful facts and findings?
9. What did the author(s) conclude?
10. Were the finding/data unequivocal? Were/are there other equally valid interpretations?
11. How would you have approached the research problem?

Suggested General Readings

1. W.G. Hopkins. Guidelines on Style for Scientific Writing. (available online at http://www.sportsci.org/jour/9901/wghstyle.html)

2. T. R. Lunsford and B. R. Lunsford. How to critically read a journal research article. *Journal of Prosthetics and Orthotics* 8 (1):24-31, 1996.

1. T. M. Wright, J. A. Buckwalter, and W. C. Hayes. Writing for the Journal of Orthopaedic Research. *J.Orthop.Res.* 17 (4):459-466, 1999.

Bio-instrumentation Section:

1. T.R. Derrick. Chapter 11: Signal Processing. In: Research Methods in Biomechanics, G.E. Robertson, G. Caldwell, J. Hamill, G. Kamen, S. Whittlesey. Human Kinetics

Press, 2004.

1. Signal Conditioning and PC-Based Data Acquisition Handbook. Chapters 1, 2, & 5. Available online at http://www.iotech.com/prsigcon.html

2. The Scientist and Engineer's Guide to Digital Signal Processing. Chapter 3:ADC and DAC (specifically the sections on quantitization and sampling theorem) S.W. Smith. California Technical Publishing, San Diego, California, 1999.
(available online through http://www.dspguide.com)

1. Strain Gauge Measurement – A Tutorial. National Instruments Application Note 078, 1998. (Available online through www.NI.com)

2. Introduction to Measurement Systems. In: Sensors and Signal Conditioning, Ramón Pallás-Areny and John G. Webster, Wiley-Interscience, New York, 1991, pg. 1-26.

1. Chapter 5:Things You Should Know about Analog Input, In: LabVIEW Data Acquisition Basics Manual, part of the LabVIEW manual set, pg. 5.1 – 5.17.

1. Inputs and Outputs. In: LabVIEW Graphical Programming – Practical Applications in Instrumentation and Control. Gary Johnson, McGraw-Hill:New York, 1994, pgs. 43-73.

1. Harry N. Norton. Biomedical Sensors : Fundamentals and Applications, Noyes Publications: Park Ridge, N.J., 1982 .

1. Measurement Techniques. In: Biomechanics of the Musculo-Skeletal System. B.M. Nigg and W. Herzog (eds.), Wiley: Chichester, 1994, pgs. 199-364.

Numerical Methods Section:

1. The Scientist and Engineer's Guide to Digital Signal Processing. S.W. Smith. California Technical Publishing, San Diego, California, 1999.
(available online through http://www.dspguide.com)

This is an informative and detailed text. The material is intended to reinforce the concepts that are covered in class. Accordingly, only certain sections are pertinent. For example, Chapter 1: pages 1-3 DSP intro
Chapter 2: pseudocode representation of algorithms, S, time domain, pdf, cumulative pdf, precision/accuracy.
Chapter 3: quantitization and sampling theorem apply to Bioinstrumentation section.
Chapter 4: general concepts from pages 67-76.
Chapter 5: to page 100 & Fourier decomposition pg. 104.
Chapter 8:Discrete Fourier Transform
Chapter 14: Digital Filters etc.

1. Robertson D.G. and Caldwell G.E. Differentiation within Chapter 1:Planar Kinematics, In: Research Methods in Biomechanics, G.E. Robertson, G. Caldwell, J. Hamill, G. Kamen, S. Whittlesey. Human Kinetics Press, 2004.

1. R. Block. Subtraction of electrocardiographic signal from respiratory electromyogram. *J Appl Physiol* 55:619-623, 1983.
2. P. Dolan, A. F. Mannion, and M. A. Adams. Fatigue of the erector spinae muscles: A quantitative assessment using "frequency banding" of the surface electromyography signal. *Spine* 20 (2):149-159, 1995.

1. D. Hary, M. J. Belman, J. Propst, and S. Lewis. A statistical analysis of the spectral moments used in EMG tests of endurance. *J Appl Physiol* 53:779-783, 1982.

1. R. S. Person and L. N. Mishin. Auto and cross-correlation analysis of the electrical activity of muscles. *Med & Biol Engng* 2:155-159, 1964.

1. J. Pezzack, R. W. Norman, and D. A. Winter. An assessment of derivative determining techniques used for motion analysis. *J Biomechanics* 10:377-382, 1977.

1. G. Smith. Padding point extrapolation techniques for the butterworth digital filter. *J Biomechanics* 22:967-971, 1989.

1. D.G.E. Robertson, J.J. Dowling. Design and responses of Butterworth and critically damped digital filters. *J Electromyogr.Kinesiol.* 13:569–573, 2003

1. G. A. Wood and L. S. Jennings. On the use of spline functions for data smoothing. *J Biomechanics* 12:477-479, 1979.

Electromyography Section

1. G. Kamen. Chapter 6: Electromyographic Kinesiology , In: Research Methods in Biomechanics, G.E. Robertson, G. Caldwell, J. Hamill, G. Kamen, S. Whittlesey. Human Kinetics Press, 2004.

1. JR Potvin. Effects of muscle kinematics on surface EMG amplitude and frequency during fatiguing dynamic contractions. *J Appl Physiol*. 82(1):144-51, 1997.

1. J. Yang and D. A. Winter. Electromyographic amplitude normalization methods: Improving their sensitivity as diagnostic tools in gait analysis. *Arch Phys Med Rehabil* 65:517-521, 1984.

1. G. L. Soderberg and T. M. Cook. Electromyography in biomechanics. *Physical Therapy* 64:1813-1820, 1984.

1. G. L. Soderberg (editor). *Selected topics in surface electromyography for use in the Occupational Setting: Expert perspectives*. US Department of Health and Human Services. Public Health Service. Centers for Disease Control - National Institute for Occupational Safety and Health (NIOSH).1992.

1. B Gerdle, NE Eriksson, L Brundin. The behaviour of the mean power frequency of the surface electromyogram in biceps brachii with increasing force and during fatigue. With special regard to the electrode distance. Electromyogr Clin Neurophysiol. 30(8):483-9, 1990.

1. RM Enoka, LL Rankin, DG Stuart, KA Volz. Fatigability of rat hindlimb muscle: associations between electromyogram and force during a fatigue test. J Physiol. 408:251-70. 1989

1. Y Umezu, T Kawazu, R Tajima, H Ogata. Spectral electromyographic fatigue analysis of back muscles in healthy adult women compared with men. Arch Phys Med Rehabil. 79(5):536-8. 1998

1. S. E. Mathiassen and J. Winkel. Quantifying variation in physical load using exposure-

vs-time data. *Ergonomics* 34 (12):1455-1468, 1991.

1. Fuglevand A. Neural aspects of fatigue. *The Neuroscientist*. Vol 2(4). 203-206. 1996

1. Measurement Techniques: EMG. In: Biomechanics of the Musculo-Skeletal System. B.M. Nigg and W. Herzog (eds.), Wiley: Chichester, pgs. 308-334. 1994

1. T Moritani, A Nagata, M Muro. Electromyographic manifestations of muscular fatigue. *Med Sci Sports Exerc*. 14(3):198-202. 1982

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4 Learning Outcomes

The goals of these courses (Research Methods in Integrative Biomechanics and Neurophysiology I & II) are to build critical analysis and application of biomechanics and neuroscience related research methods and analysis, as well as to develop numeracy along with scientific writing and oral presentation skills. The overarching philosophy is to establish research competency by developing tenants of scientific inquiry: critical evaluation and application of research methods and effective scientific writing and presentation; all done in the context of the scientific method. The course begins with establishing a foundation in the principles of signal analysis, and then proceeds to apply these concepts in evaluation and

application of research methodologies. These methodologies in of themselves are studied in-depth, and span across the related research dimensions to provide a comprehensive basis in understanding biomechanics & neuroscience inquiry.

The courses have continual and multidimensional assessment. Evaluation will be provided in an ongoing basis for in-lab work, reports, assignments, presentations, and examinations. Labs, lab reports, oral presentations and assignments allow for assessment of the translation of concepts to applications, proficiency in numeracy, as well as written and oral communication skills. The examinations evaluate conceptual understanding and critical evaluation of material. Peer evaluation of written assignments and presentations offer an additional dimension of assessment.
Numeracy is developed in both conceptual and applied dimensions. Conceptual underpinnings are provided in lecture material for signal analysis, numerical data methods and programming. Applied numeracy is achieved via analysis of lab data, data processing assignments, and introduction to programming as related to numerical analysis.

Written communication skills will be developed in consideration of logical, concise, and in-depth scientific writing; stylistic aspects will be emphasized in relaying information clearly and in an organized manner. Logic in scientific writing will be developed by 1) critical analysis of primary literature articles, focusing on the scientific method aspects of establishing the research question and hypotheses, the efficacy of methods applied in addressing the scientific question, the interpretation and conclusions drawn from the results, 2) written lab reports based on exploration of analytical techniques, building upon concepts presented and discussed in lecture, 3) development of an individual research proposal, complete with establishing purpose, hypotheses, methods, along with preliminary analysis of data.
Stylistic writing skills will be emphasized throughout the course: all written work will be placed in the context of clear and concise writing. Stylistic feedback on initial submissions of written reports will be provided (via instructor and peers) for follow-up self-evaluation and revision of writing approach. Evaluation of primary literature articles will involve appraisal of grammar and style. Peer assessment will include reflection on one’s own writing in the context of considering other’s writing styles.

Oral communication skills will be developed in a number of ways. In all cases, the emphasis will be placed upon effectively communicating the material of the presentation. Formal oral presentations will be done in 1) the critical analysis of primary literature article, 2) the research proposal and initial results (both as mentioned above). Presentations will be evaluated by peers, and ensuing discussions and questions student-led. Moreover, lectures are designed in an active learning approach, via interactive discussion of concepts.
Interpersonal communication will be developed via work in lab and assignment groups.

By the end of this course, students will be able to:

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Critically evaluate primary literature, particularly in the context of methods and analysis techniques

2. Understand and apply numerical analyses, including via mathematical programming
3. Effectively communicate via formal writing, with an emphasis on scientific writing
4. Effectively communicate via oral presentation
5. Work well with peers to meet learning goals through collaboration

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5 Teaching and Learning Activities

5.1 Lecture schedule

Date	Lecture Topic (Fri)	Date	Assignment/Lab (Mon)
Sept 11 *(Steve)*	Overview of Course Transducers and Signals	Sept 14	
Sept 18 *(Steve)*	Fourier analysis, Mechanical systems, Filtering	Sept 21	
Sept 25 *(Steve)*	Filtering continued, Differentiation and Integration	Sept 28	***Lab 1: Administered virtually*** *Digital Sampling, Filtering*
Oct 2 *(Steve)*	Linear systems, Modeling	Oct 5 *(Steve)*	**Assignment:** *Filtering, differentiation, integration,* *Lab 1 due*
Oct 9 *(Steve)*	Review Session *Assignment due*	Oct 12	*Thanksgiving Holiday*
Oct 16	No class	Oct 19	***Midterm Exam***

			Format TBD
Oct 23 *(Leah)*	EMG 1 *(X-bridge theory; recruitment; instrumentation; vel-force relationships)*	Oct 26 *(Leah)*	
Oct 30 *(Leah)*	EMG 2 *(Force & fatigue relationship; EMG analysis techniques)*	Nov 2 *(Leah)*	***Lab 2***: ***Administered Virtually*** Surface & Indwelling EMG of FDI muscle *Lab 2 due November 11th*
Nov 6 *(Leah)*	*EMG 3* *Finish fatigue concepts*	Nov 9	
Nov 13 *(Leah)*	Numerical Methods 2 *(Correlations; spike triggered avg)*	Nov 16th	Summary Paragraph for Fatigue paper Due to Leah
Nov 20	***Presentations Fatigue paper***	Nov 23	Review Session
Nov 27	***Final Exam***		

6 Assessments

6.1 ASSESSMENT

Weight of Assessment	Activity	Learning Outcome Addressed
10%	Assignment	1,2,5
30%	2 Laboratory Reports (15% each)	1,2,3,5
20%	Oral Presentation of Research Article/Proposal	1, 4
20%	Midterm Exam	2,3

Weight of Assessment	Activity	Learning Outcome Addressed
20%	Final Exam	2, 3

6.2 IMPORTANT DATES

Laboratory Report (Bioinstrumentation): Due October 5th

Assignment: Due October 9th

Midterm: October 19th

Fatigue presentation: Choose paper by November 9th (email Leah), Paper summary due November 16th, Final presentation November 20th

Laboratory Report 2 (EMG): Due November 11

Final: November 27

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7 Department of Human Health and Nutritional Sciences Statements

7.1 Academic Advisors

If you are concerned about any aspect of your academic program:

- Make an appointment with a program counsellor in your degree program. B.Sc. Academic Advising or Program Counsellors

7.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist. http://www.learningcommons.uoguelph.ca/
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can

be found at: http://www.lib.uoguelph.ca/get-assistance/studying/chemistry-physics-help and http://www.lib.uoguelph.ca/get-assistance/studying/math-stats-help

7.3 Wellness

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance. https://www.uoguelph.ca/counselling/
- Student Health Services is located on campus and is available to provide medical attention. https://www.uoguelph.ca/studenthealthservices/clinic
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations. http://www.selfregulationskills.ca/

7.4 Personal information

Personal information is collected under the authority of the University of Guelph Act (1964), and in accordance with Ontario's Freedom of Information and Protection of Privacy Act (FIPPA) http://www.e-laws.gov.on.ca/index.html. This information is used by University officials in order to carry out their authorized academic and administrative responsibilities and also to establish a relationship for alumni and development purposes.

For more information regarding the Collection, Use and Disclosure of Personal Information policies please see the Undergraduate Calendar. (https://www.uoguelph.ca/registrar/calendars/undergraduate/current/intro/index.shtml)

8 University Statements

8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

8.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

8.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

8.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19

website (https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

8.10 Illness

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.
