University of Guelph
College of Biological Science
Department of Human Health and Nutritional Science

COURSE OUTLINE

Research Methods in Integrative Biomechanics and Neurophysiology
IHHNS*6810
Fall 2016

I) COURSE INFORMATION:

Professors:
Dr. Leah Bent Office: ANNU 331 email: lbent@uoguelph.ca
Dr. Stephen Brown Office: ANNU 330B email: shmbrown@uoguelph.ca

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.

Credit Value: 0.5 credits
Pre-requisites: None
Course Lecture Schedule: Fridays 9:00-12:00; Room SSC 3317
Course Lab Schedule: Mondays 9:00-12:00; JTP 208B for Lab 1, ANNU 373 for Lab 2

II) LEARNING GOALS AND RATIONALE:

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.

Learning Outcomes:

By the end of this course students will 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

III) TENTATIVE SCHEDULE:

Date	Lecture Topic (Fri)	Date	Assignment/Lab (Mon)
Sept 9 *(Steve)*	Overview of Course Signal Analysis *(Properties of signals; time, amplitude domains; frequency domain)*	Sept 12	
Sept 16 *(Steve)*	Numerical Methods *(Differentiation, integration smoothing, filters; transducers)*	Sept 19	
Sept 23 *(Steve)*	Bioinstrumentation *(Transducers)*	Sept 26 *(Dan)*	***Lab 1:*** *Data Acquisition, Frequency Response*
Sept 30 *(Steve)*	Bioinstrumentation & Numerical Methods: Summary	Oct 3 *(Steve)*	**Assignment:** *Filtering, differentiation, interpolation, extrapolation; re-sampling* *Lab 1 due*
Oct 7 *(Steve)*	Review Session *Assignment due*	Oct 10	*Thanksgiving Holiday*
Oct 14	No class	Oct 17	***Midterm Exam***

Oct 21 *(Leah)*	Numerical Methods 2 *(Correlations; spike triggered avg)*	Oct 24 *(Leah)*	
Oct 28 *(Leah)*	EMG 1 *(X-bridge theory; recruitment; instrumentation; vel-force relationships)*	Oct 31 *(Leah)*	***Lab 2 GroupA**:* Surface & Indwelling EMG of FDI muscle
Nov 4 *(Leah)*	EMG 2 *(Force & fatigue relationship; EMG analysis techniques)*	Nov 7	***Lab 2 Group B**:* Surface & Indwelling EMG of FDI muscle *Lab 2 Group A due*
Nov 11 *(Leah)*	*Finish Fatigue here if necessary*	Nov 14	*Lab 2 Group B due*
Nov 18	***Presentations Fatigue paper***	Nov 21	Review Session
Nov 25	***Final Exam***		

IV) SEE END OF THIS DOCUMENT FOR OPTIONAL READINGS

V) ASSESSMENT

For HHNS 6810:

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
20%	Final Exam	2, 3

VI) Course and University Policies

a. University Policies

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 in writing, with your name, id#, and e-mail contact. See the graduate calendar for information on regulations and procedures for Academic Consideration: https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/pdffiles/genreg.pdf

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact Student Accessibility Services as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.csd.uoguelph.ca/csd/

Academic Misconduct

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 discourages misconduct. 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.

The Academic Misconduct Policy is detailed in the Graduate Calendar: https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/pdffiles/genreg.pdf

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

Drop Date
The last date to drop one-semester courses, without academic penalty, is the 40th class day. To confirm the actual date, please see the schedule of dates in the Graduate Calendar. For regulations and procedures for Dropping Courses, see the Graduate Calendar: https://www.uoguelph.ca/registrar/calendars/graduate/2015-2016/sched/index.shtml

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.

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

Resources
The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
http://www.uoguelph.ca/registrar/calendars/index.cfm?index

b. INSTRUCTOR POLICIES:

Technology in the classroom

Feel free to bring your laptop to lectures, but only use it in a manner that will not disturb those around you. Please do not use your laptop for anything other than activities related to this physiology course. Turn your cell phones off, or put them on silent, and do not text-message during class.

VII) Campus Resources

If you are struggling to succeed academically:

- 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/

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.uoguelph.ca/~ksomers/

If you have a documented disability or think you may have a disability:

- The Centre for Students with Disabilities (CSD) can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability. For more information, including how to register with the centre please see: https://www.uoguelph.ca/csd/

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.

3. 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:

4. 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.

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

6. 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)

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

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

9. 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.

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

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

12. 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:

13. 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, Σ, 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.

14. 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.

15. R. Block. Subtraction of electrocardiographic signal from respiratory electromyogram. *J Appl Physiol* 55:619-623, 1983.

16. 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.

17. 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.

18. 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.

19. 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.

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

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

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

Electromyography Section

23. 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.

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

25. 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.

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

27. 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.

28. 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.

29. 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

30. 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

31. S. E. Mathiassen and J. Winkel. Quantifying variation in physical load using exposure-vs-time data. *Ergonomics* 34 (12):1455-1468, 1991.

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

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

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