

University of Waterloo
ECE 608: Quantitative Methods in Biomedical Engineering
Course Syllabus for Spring 2019

Instructor: Jason Au, PhD (jason.au@uwaterloo.ca)

Class Times: ████████████████████

Class Location: ██████████

Office Hours: ██)

Course Description:

This biomedical engineering core course focuses on topics related to the use of quantitative tools in biomedical engineering research studies. It will teach students how to conduct statistical analysis of biomedical data, design biomedical experiments that can offer statistical insight, and apply computational methods to solve problems in biomedical engineering. Educational emphasis will be placed on developing students' core competence in biostatistics and biomedical computing, so as to prepare them to pursue biomedical engineering investigations that are backed by quantitative reasoning and numerical insights.

Intended Learning Outcomes:

This course is intended for engineering research students, and will therefore place greater emphasis on the application of statistics, rather than their mathematical basis, to solve real-world research questions in biomedical engineering. By the end of the course, the student will be able to:

1. Identify and apply common methodological designs to solve basic problems in biomedical engineering;
2. Select the appropriate statistical analysis to test your research questions and hypotheses;
3. Conduct statistical analyses to test research questions and hypotheses;
4. Present the Results section of a research paper at a publishable standard; and,
5. Interpret and critically evaluate the Statistical Analysis/Results sections of research papers

Course Expectations

- Students are expected to regularly check **LEARN** (learn.uwaterloo.ca) for lecture updates and course announcements.
- Students are responsible for any course content that is delivered via **LEARN** (including lecture slides, assignments and grading rubrics).
- Is it the responsibility of the student to take all necessary steps to find out about course changes including, but not limited to, class attendance, changes to schedules, announcements and instructions.

- The instructor will only communicate with students via their official University of Waterloo email account. All email communication should include the course title (ECE608) in the subject line, as well as your full student name in the body of the text.
- A Note on Student Collaboration:
 - Students are strongly encouraged to talk about assigned work, share ideas, or share code fragments. However, each final submission is to be composed individually. Direct copying of a solution, or providing the copy, is considered plagiarism and will not be tolerated. The following are two important points to note about collaboration:
 - ‘Separation’: After you discuss an assignment with others, you should separate your own work from any shared materials used in the learning process. In addition to avoiding direct copying, this will significantly improve your speed of learning from an alternative source.
 - ‘Disclosure’: Should you submit any work directly from help you received, you need to identify this material and indicate the original course. You may lose whatever portion of the grade relates to the copied part; however, properly sourced material is not plagiarism and you will demonstrate learning from the parts you were able to complete on your own.

Required Materials

Textbook: There is no required textbook for this course, but it is encouraged that students supplement the core lecture material for further interest in the mathematical underpinnings of inferential statistics.

Below are two suggested resources:

- S. Kuiper and J. Sklar, *Practicing Statistics: Guided Investigations for the Second Course*. Boston: Pearson Education Inc., 2013. ISBN 0-321-58601-8.
- G. Grolemund and H. Wickham. *R for Data Science*. O’Reilly Media, 2017. [Available online, free, at r4ds.had.co.nz]

Software:

- The main statistical programming environment for this course will be R. As a portion of the course lectures will involve interactive demonstrations and statistical computation, students are encouraged to set up the programming environment on your own laptop and bring it with you to class meetings.
 - The R language and environment for statistical computing is available from the R Foundation via links at the following url: <https://www.r-project.org/>
 - A simple integrated development environment called RStudio Desktop is available at the following url: <https://rstudio.com/products/RStudio/>

Assessments

The final grade for this course will be assigned on the following:

Statistical Critique	10%
Weekly Assignments (8 @ 5% each)	40%
Final Exam	50%

Assessments

Below are more detailed descriptions of the assessments tied to this course:

Statistical Critiques

Critical evaluation of statistical methods is not only important for writing your own research papers, but also in how to interpret primary research articles and evaluate their strengths and weaknesses in your field. Students will be required to submit a one-page (double spaced, 1" margins, Arial 12 font) review on the statistical methods and results presentation in a primary research article. The critique will be chosen from a list provided by the instructor. These critiques will be due by:

DATE: July 17th, 2019

Written Assignments

The goal of each assignment is to develop hands-on learning of basic statistical techniques using the R environment. There will be **eight** assignments worth 5% each, related to different topics throughout the course. The problem and format for each assignment will be posted to LEARN, and will typically involve the submission of your R code, as well as a short written statistical reporting summary that summarizes your findings.

ASSIGNMENT #1: Data Wrangling in R	DUE: May 29
ASSIGNMENT #2: T-tests	DUE: June 5
ASSIGNMENT #3: ANOVA	DUE: June 26
ASSIGNMENT #4: Power	DUE: July 3
ASSIGNMENT #5: Regression	DUE: July 10
ASSIGNMENT #6: Regression 2	DUE: July 17
ASSIGNMENT #7: Receiver-Operator Curves	DUE: July 24
ASSIGNMENT #8: Validity	DUE: July 30 (Tuesday)

Exam

This course will have one final exam worth 50% of your final grade. Content for this exam will be based on lecture material, assignments and guest lectures.

DATE: TBD

COURSE SCHEDULE

Date	Topic
May 8	Introduction, Research Design and Methodology, Introduction to R
May 15	R data wrangling, Data Visualization, and Basic Probability
May 22	Simple Inferential Statistics: T-tests and parametric assumptions
May 29	Analysis of Variance and post-hoc procedures
June 5	Guest Lecture
June 12	Factorial ANOVAs
June 19	Effect sizes, power, and sample size calculations
June 26	Simple Regression and Multiple Regression
July 3	Logistic Regression and Poisson Regression
July 10	Error and Receiver-Operator Curves
July 17	Validity and Reliability
July 24	Concepts in non-parametric testing and Bayesian statistics + Review
TBD	Final Exam

Institutional Policy Statements**Academic Integrity**

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect, and responsibility. Check the following url for more information.

<https://uwaterloo.ca/academic-integrity>

Grievance

A student who believes that a decision affecting some aspect of his or her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, found at the following url.

<https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-70>

When in doubt, please be certain to contact the department's administrative assistant, who will provide further assistance.

Discipline

A student is expected to know what constitutes academic integrity (see the Academic Integrity section above) to avoid committing an academic offence, and to take responsibility for his or her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about rules for group work or collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, available at the following url.

<https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-71>

For typical penalties check the Guidelines for the Assessment of Penalties, available at the following url.

<https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/guidelines/guidelines-assessment-penalties>

Appeals

A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition), or Policy 71, Student Discipline, may be appealed if there is a ground. A student who believes he or she has a ground for an appeal should refer to Policy 72, Student Appeals, available at the following url.

<https://uwaterloo.ca/secretariat-general-counsel/policies-procedures-guidelines/policy-72>

Note for students with disabilities

The AccessAbility Office (formerly Office for Persons with Disabilities or OPD), located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AccessAbility Office at the beginning of each academic term. For more information, see the following url.

<https://uwaterloo.ca/accessability-services>