

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/>

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.

STAT*4350/6821 : Applied Multivariate Statistical Methods

Course Outline

Instructor: Ayesha Ali

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Office: MACN 509

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Office Hours: Fridays 10:00 – 11:00 am EST

(When office hours conflict with the midterm or class presentations, they will be moved to another time)

Asynchronous Component: video lectures available on Courselink

Synchronous Component: group meetings Wednesdays 10:00 – 11:20 am EST

Pre-requisites: (1 of MATH*1160, MATH*2150 or MATH*2160), STAT*3110, STAT*3240

Required Text: *Applied Multivariate Statistics with R*, D. Zelterman, Springer, 2015. (online in library)

Recommended Texts:

Applied Multivariate Statistical Analysis, 5th Ed., Johnson and Wichern, Preston Hall, 2002.

Methods of Multivariate Analysis, 3rd Ed., Rencher and Christensen, Wiley, 2012. (online in library)

Calendar Description: This course introduces the multivariate normal, Wishart and Hotelling's T-square distributions. Topics covered include: statistical inference on the mean vector, canonical correlation, multivariate analysis of variance and covariance, multivariate regression, principal components analysis, and factor analysis. Topics will be illustrated using examples from various disciplines. For graduate students, topics that are more current to the field will also be discussed such as: multivariate adaptive regression splines; projection pursuit regression; and wavelets.

Course Objectives and Outcomes: The objective of this course is to acquaint students with the concepts, applicability, and methods of multivariate data analysis. Students who have successfully completed this course will be expected to:

- Have a general knowledge and understanding of many of the key concepts, theoretical approaches and assumptions needed for dealing with multivariate problems;
- Derive some fundamental classical results of multivariate analysis;
- Recognize types of problems (e.g., classification versus clustering) and the appropriate method(s) of analysis;

- Analyze multivariate data using statistical software (e.g. using R and related R packages);
- Develop independent and critical thinking skills regarding multivariate data and data reduction;
- Describe statistical methods and analysis results for multivariate data to a non-statistician in a written report with appropriate tables and figures.

Course Description: We will begin with a brief review of matrix algebra and random vectors. We will then move on to the multivariate normal distribution and making inferences about one or more means. Relevant distributions also include the Hotelling's T-squared distribution and the Wishart distribution. Statistical methods of analysis include multivariate analysis of variance and covariance (MANOVA, MANCOVA), multivariate regression, and dimension reduction methods including principal components analysis, factor analysis and canonical correlation analysis. Other important multivariate techniques are discrimination, classification and clustering methods. Time permitting, or through projects/presentations, we will look at advanced topics such as multivariate adaptive regression splines, projection pursuit regression, graphical Markov models, and methods for discrete multivariate data.

Course Assessment:	STAT*4350	STAT*6821
Participation	10%	10%
Assignments (7, equally weighted)	30%	30%
Midterm Exam (Fri. Oct. 30, in-class)	25%	15%
Presentation (graduate students only)	—	15%
Project Proposal (Fri. Nov. 6)	5%	5%
Final Project (Fri. Dec. 4, 11:59pm)	30%	25%

Schedule of Important Dates:

Fri. Sept. 25	Assignment 1 due
Fri. Oct. 2	Assignment 2 due
Fri. Oct. 9	Fall Study Break
Fri. Oct. 16	Assignment 3 due
Fri. Oct. 23	Assignment 4 due
Fri. Oct. 30	MIDTERM (office hours will be moved)
Fri. Nov. 6	Project Proposal due
Fri. Nov. 13	Assignment 5 due
Fri. Nov. 20	Assignment 6 due
Fri. Nov. 27	Assignment 7 due
Fri. Dec. 4	Final Project due

Participation: Students are expected to participate in the pre-scheduled synchronous group meetings. In these meetings, we will focus on a data set or problem and then split into groups to discuss particular aspects of analyzing such data or addressing the problem. Some data sets/problems may be related to assignment questions. Each week a different student will be responsible to lead the discussion and/or take notes. Every student in the group will be asked to rate the other group members' participation, which will partially contribute to the participation component of your final grade.

Assignments: Assignments will be posted on Courselink and due at 11:59pm on the due date per the Schedule of Important Dates. Students are encouraged to discuss assignment questions with each other, but you are expected to complete the assignments yourself and to submit your own work. See below for the University of Guelph policies on Academic Misconduct.

Presentation: (Graduate students only). The presentation will involve finding a recent article or book chapter that covers an advanced topic in multivariate analysis. You will have to read the article/chapter,

understand it, and present it to the class in a twenty to twenty-five minute talk. You are strongly encouraged to select a method that will be used in your final project. In other words, you present the article for your presentation, and then apply that method to a data set for your final project. The dates and order of presentations will be determined later on in the semester. BEFORE you start working on the presentation, inform the instructor of your choice. The instructor may deem the article not suitable for this presentation and/or suggest an alternate article. However, **you are encouraged to select the paper yourself.**

Final Project: The project will consist of a written statistical report of a particular application of a multivariate technique to analyse a data set. **You are responsible for proposing your own project topic and finding suitable data.** You will have to submit a project proposal to the instructor approximately one month before the project due date. Graduate students are expected to use advanced multivariate methods that have not been covered in class, preferably one that can be presented to the class for the Presentation component of the course grade.

Usually, a project will require data exploration and a clear understanding of the materials presented in class or any reading assignments. The project is an extremely important tool, not only to help you understand the course subject matter, but also to help you develop a critical view of data analysis and refine your written communication skills. Your report must document the procedures used in your project and relevant findings. **Raw computer output is not acceptable.** Further details for the project will be given out later in the semester.

Late Policy: The instructor reserves the right to not accept late assignments, projects or presentations. If you cannot submit such assessments on time, you are advised to notify the instructor as soon as possible to discuss the matter. In some instances, a late penalty may apply.

Computing: We will make use of computing since data analysis is a central part of the course material. It is assumed that you already have some experience with the R statistical language, though not necessarily with respect to the topics covered in this course. However, there are several online tutorials available on the CRAN website to help you in this regard (<http://cran.r-project.org/>). The most recent version of R is also freely available from this site. The required textbook is tailored to multivariate analysis using R.

Courselink: Class announcements, assignments, handouts and partial lecture notes will be posted on Courselink and students are expected to regularly check the course website on Courselink.

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

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. [See the undergraduate calendar for information on regulations and procedures for Academic Consideration.](#)

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>

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.

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.

More information: www.uoguelph.ca/sas

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 Undergraduate Calendar.](#)

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 explicitly 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.