University of Manitoba – Department of Statistics

STAT 7140 : Linear Models

Fall Term 2016

Course Details

Course Number & Title	STAT 7140, Linear Models
Section & CRN	Section A01, CRN: 10760
Class Schedule	Tu.Th. 1:00 PM – 2:15 PM
Class Location	316 Machray Hall
Prerequisites	Consent of the instructor.

Instructor Contact Information

The course will be jointly taught by:

From September 8 – October 25

Instructor I	Elif Acar
Office Location	369 Machray Hall
Phone	(204) 480-1820
Email	elif.acar@umanitoba.ca
Office Hours	MW 10:30 AM – 12:00 PM, or by appointment.

From October 27 – December 8

Instructor II	Saumen Mandal
Office Location	328 Machray Hall
Phone	(204) 474-9661
Email	saumen.mandal@umanitoba.ca
Office Hours	Tu.Th. 9:45 AM – 11:15 AM, or by appointment.

If the scheduled office hour times are not convenient for you, please phone, email or speak to the instructors to arrange an alternate time to meet.

General Goals for this Course

This course aims to provide students with a solid understanding of the theory and methods of linear models, including the theoretical foundations of the regression analysis and analysis of variance.

Textbook and Other Materials

Textbook	*A First Course in the Theory of Linear Statistical Models*, Myers, R. H. and Milton, J. S., PWS-KENT Publishing Company, Boston, 1991, ISBN: 0-534-91645-7. Note that this book is out of print. With the copyright permission from the publisher, our bookstore has made copies of this text for you. You can buy it from the bookstore.
Lecture notes	Some notes will be provided. Course materials will be posted on the UM Learn system.
Supplementary Text	*Linear Models*, Searle, S. R., Wiley, New York, 1971. *Linear Models in Statistics*, Rencher, A. C. and Schaalje, G. B., 2nd Edition, Wiley-Interscience, 2008.
Statistical Software	There is no software requirement for this course. If needed, you can use any software of your choice. Some software output from the textbook may be used.

Course Assessment

Assignments	There will be no formal assignment for this course. We will provide a number of exercises and questions for you to practice.
Term Tests	Each instructor will give an in-class term test. These are tentatively scheduled for **October 4** and **November 22**. The term tests are closed book, and cover only the topics taught up-to-date by the corresponding instructor. There will be no formula sheet for the tests. Relevant statistical tables will be provided if required. A non-programmable calculator will be needed. Note that graphing calculators are not permitted. There will be no make-up for the term tests. Students who miss a term test with legitimate reasons will have the term test weight added to the exam of the instructor.
Exams	Each instructor will give a cumulative exam. The first exam is scheduled to be held outside of class time on **October 25**, and will cover topics taught by Dr. Acar. The second exam will be held during the final exam period. The second exam date will be set by the Department of Statistics and announced later in the semester. The second exam will cover topics taught by Dr. Mandal. Exams are closed book. There will be no formula sheet for the exams. Relevant statistical tables will be provided if required. A non-programmable calculator will be needed. Note that graphing calculators are not permitted.
Grading timeline	Work will be graded and returned within two weeks of submission.

Course Evaluation and Grading Scheme

Final Marks The final mark for the course will be based on the following components.

Term Test I	20%
Exam I	30%
Term Test II	20%
Exam II	30%

Letter Grades The following cutoffs will be used when assigning the letter grades.

Letter Grade	Mark out of 100
A+	90 – 100
A	80 – 90
B+	75 – 80
B	70 – 75
C+	65 – 70
C	60 – 65
D	50 – 60
F	below 50

Outline of Topics

The following is a non-exhaustive list of topics to be covered in the course. In the beginning, you will notice that we will be revisiting some topics in Linear/Matrix Algebra and Multivariate Statistics. Then we will start advanced topics. Our primary goal will be to reinforce the fundamental concepts, and to have a solid understanding of Linear Models.

1. **Introduction - Matrix Algebra** (Chapter 1) (E.Acar)
    - Matrix Operations
    - Matrix Inverse and Orthogonality
    - Eigenvalues, Rank and Trace
    - Idempotent Matrices and Properties
    - Row and Column spaces

2. **Quadratic Forms and Their Distributions** (Chapter 2) (E.Acar)
    - Quadratic Forms
    - Differentiation of Quadratic Forms
    - Expectation and Variance of Vectors and Matrices
    - Distribution of Quadratic Forms
    - Independence of Quadratic Forms

3. **Estimation in the Full Rank Model** (Chapter 3) (E.Acar)

    - Least Squares Estimation, Gauss-Markoff Theorem
    - Maximum Likelihood Estimation
    - Interval Estimation
    - Joint Confidence Region on the Regression Coefficients
    - Generalized Least Squares

4. **Hypothesis Testing in the Full Rank Model** (Chapter 4) (S. Mandal)

    - Testing for Model Adequacy
    - Testing for a subvector of the regression coefficients
    - Partial and Sequential Tests
    - The General Linear Hypothesis
    - Likelihood Ratio Tests

5. **Estimation in the Less Than Full Rank Model** (Chapter 5) (S. Mandal)

    - Model and Reparameterization
    - Generalized Inverse and Properties
    - Estimability of Parametric Functions, Gauss-Markoff Theorem
    - Interval Estimation

6. **Hypothesis Testing in the Less Than Full Rank Model** (Chapter 6) (S. Mandal)

    - Hypothesis Testing in a General Setting
    - Reparameterization: One-Way Classification
    - Testing for a Treatment Contrast
    - Two-Way Analysis of Variance
    - Randomized Complete Block Designs

    If time permits, the following topic will be considered.

7. **Analysis of Covariance (ANCOVA)** (Chapter 7) (S. Mandal)

Note that the topics covered by each instructor may slightly change depending on the course progress.

Important Dates

The following dates are important to how the course will progress throughout the term.

Date	Information
Sep 8	First lecture
Sep 21	End of the registration revision period
Oct 4	**Term Test I**
Oct 6–7	Fall term break, no class
Oct 25	**Exam I**
Nov 18	Last day to VW the course
Nov 22	**Term Test II**
Dec 8	Last lecture
Dec 12	First day of final examination period
Dec 22	Last day of final examination period

The dates for the term tests are tentative (and subject to change at our discretion and/or based on the learning needs of the students). Changes are subject to Section 2.8 of the ROASS Procedure.

Technology in the Classroom

It is the general University of Manitoba policy that all technology resources are to be used in a responsible, efficient, ethical and legal manner. Students should restrict their use of technology to those approved by the instructor *for educational purposes only.* Electronic messaging, email, social networking, gaming, etc. should be avoided during class time. Cell phones should be turned off. If a student is on call for emergencies, their cell phone should be on vibrate mode and the student should leave the classroom before using it.

Class Communications

The University requires all students to activate an official U of M email account, which should be used for all communications between yourself and the university (including all your instructors). All these email communications should comply with the University's policy on electronic communication with students, which can be found at: `http://umanitoba.ca/admin/governance/governing_documents/community/electronic_communication_with_students_policy.html`

Academic Dishonesty

It is important that you understand what constitutes academic dishonesty and that you are familiar with the very serious consequences. Links to resources that describe academic dishonesty (including plagiarism, cheating, inappropriate collaboration and examination impersonation, as well as typical penalties) can be found at:
`http://umanitoba.ca/faculties/science/undergrad/resources/webdisciplinedocuments.html`

Copyrights

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Lectures No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without our permission.

More details are available online at: `http://umanitoba.ca/copyright/`

Student Accessibility Services

If you are a student with a disability, please contact Student Accessibility Services (SAS) for academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g. mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

ROASS Schedule A

Schedule "A" of the *Responsibilities of Academic Staff with regards to Students* (ROASS) policies of the University of Manitoba lists resources and policies for students. It is important that you familiarize yourself with these resources and policies. This document is available from the Department of Statistics web page at:
`http://umanitoba.ca/science/statistics/files/pages/2016/09/Schedule-A-ROASS-Statistics.pdf`