<h1 style="text-align:center">The University of Manitoba</h1>

<h2 style="text-align:center">STAT 7140 – Linear Models
Winter Term 2021</h2>

<h2 style="text-align:center">Course Outline</h2>

Course Number & Title: STAT 7140, Linear Models.

Time, Location & CRN: Tuesdays & Thursdays 10:00 a.m. – 11:15 a.m., Online - Cisco Webex in UM Learn. CRN: 60147.

Instructor: Dr. Saumen Mandal

Department of Statistics.
E-mail: saumen.mandal@umanitoba.ca

Office Hours: Tuesdays & Thursdays: 30 minutes after each class (11:15 a.m. – 11:45 a.m.).

If the above times are not convenient for you, please email me to arrange an alternate time to meet.

Web Pages: UM Learn: http://umanitoba.ca/umlearn
Statistics: https://www.sci.umanitoba.ca/statistics

<h3 style="text-align:center">Calendar Description</h3>

Theory of linear models, regression analysis, and analysis of variance. Prerequisite: Consent of instructor.

<h3 style="text-align:center">Textbook and Course Materials</h3>

A First Course in the Theory of Linear Statistical Models by R.H. Myers and J.S. Milton, PWS-KENT Publishing Company, Boston. ISBN: 0-534-91645-7.

The textbook is required. This book is available both in physical (hard) copy and electronic form (e-Book). This book can be purchased in our Bookstore. The price for the electronic version (e-book) is cheaper than the hardcopy. The e-Book can be purchased through the Bookstore digital book link: https://www.campusebookstore.com/integration/AccessCodes/default.aspx?bookseller_id=33&Course=STAT+7140&frame=YES&t=permalink

You can also go to the bookstore and purchase the physical (hard) copy directly from there. If you would like to order the book for pickup or delivery, you can go to this link and search by department/course#: http://bookstore.umanitoba.ca/SelectTermDept

Detailed Lecture Notes and other materials (e.g. assignments, SAS code) will be posted in UM Learn. Online lectures will be conducted during class times over Cisco Webex. Access to the class recordings and the live lectures will be available through UM Learn under Communications > Cisco Webex. If you miss a class, watch the recordings. Some pre-recorded videos may also be posted in UM Learn contents page.

Supplementary References: Searle, S.R. *Linear Models*. Wiley, New York, 1971.
Rencher, A.C. and Schaalje, G.B. *Linear Models in Statistics*. 2nd Edition, Wiley-Interscience, 2008.

Statistical Software

SAS statistical software will be used for computational purposes and matrix operations. Instructions will be given in the class. Data sets and SAS code will be posted in UM Learn. You can install a copy of the SAS University Edition in your computer for free:
http://www.sas.com/en_us/software/university-edition.html#for-students-learners
Documentation, including installation guides:
http://support.sas.com/software/products/university-edition/#s1=3

Assignments, Midterm Test and Final Exam

Crowdmark: The assignments, midterm test, and final exam will be conducted using the **Crowdmark** software, an online grading tool. All assignments and exams will be written by you on paper and then scanned (or taken a photo of your paper) and uploaded through a link you will be provided over email. Please make sure your scanned/photo pages are sharp and readable. I will provide the detailed information and instructions throughout the course.

Assignments: There will be two assignments, each counting equally (15% each) toward your final grade. Assignments will include theoretical problems and some computing problems. Whenever you answer a question using SAS, you must attach the output (highlight the appropriate sections and answer the questions using the output). Assignments are to be submitted to the Crowdmark link provided in your email by the due date and time. No late assignments will be accepted.

Midterm Test: There will be one in-class midterm test. The tentative date is March 18. The syllabus for the midterm test will be the materials covered until March 9. There will be no make-up midterm test. Students who miss a test with legitimate reasons and notify me within 48 hours will have the midterm weight added to the final exam. The test questions will be sent to all students via a Crowdmark email. You will be expected to write your answer to each question on a sheet of paper and then take a picture or scan a copy of your images and upload them to Crowdmark. A calculator will be required to complete the calculations. Crowdmark keeps record of all page views and upload attempts. You must upload all your answers by the cut off time (submission deadline). Late submissions will not be accepted. Detailed instructions will be provided before the test.

Final Exam: The final exam will be of three hours in duration and will be scheduled by the Student Records Office. The final exam will cover the whole syllabus. The exam questions will be sent to all students via a Crowdmark email. You will be expected to write your answer to each question on a sheet of paper and then take a picture or scan a copy of your images and upload them to Crowdmark. A calculator will be required to complete the calculations. Crowdmark keeps a record of all page views and upload attempts. You must upload all your answers by the cut off time (submission deadline). Late submissions will not be accepted. Detailed instructions will be provided before the exam.

Both Midterm test and final exam will be closed book. You will be required to be on Cisco Webex or Zoom, with your camera on during the test and exam. You will not have access to any course materials (for example, the textbook, materials that are posted on UM Learn). If statistical tables or anything else is needed, it will be provided during the test and exam. You are not allowed to use the software SAS or any other software during the test or exam. A calculator will be required to complete the calculations. All other resources, web browsing and communication with other individuals are strictly prohibited. Inappropriate collaboration, plagiarism, or contract cheating of any kind will be dealt with severely and forwarded to the appropriate disciplinary committee at the University of Manitoba.

If there is a need to change any of these tools or instructions, I shall let you know well in advance.

<p style="text-align:center">**Course Evaluation and Grading Scheme**</p>

The final mark for the course will be obtained from the following rule:

Assignments (2): 30% (15% each)
Midterm Test: 30%
Final Exam: 40%

Work should normally be graded and returned promptly. It is expected to return the graded materials within two weeks of submission. Marks for the assignments and midterm test will be posted on UM Learn gradebook.

The following are the minimum percentage grades required to receive the final grades:
A+ (90%), A (80%), B+ (75%), B (70%), C+ (65%), C (60%), D (50%), F (below 50%).

<p style="text-align:center">**General Goals and Course Contents**</p>

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)
- Matrix Operations
- Orthogonality, Eigenvalues, Eigenvectors, Rank and Trace
- Idempotent Matrices and Properties
- Row and Column spaces

2. Quadratic Forms and Their Distributions (Chapter 2)
- 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)
- 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)
- Testing for Model Adequacy
- Testing for a sub-vector 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)
- 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)
- 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 (ANOCOVA) (Chapter 7)

Important Dates

The following dates are important to how the course will progress throughout the term. The dates are tentative and subject to change at my discretion and/or based on the learning needs of the students.

Jan. 19: First lecture - course overview.
Jan. 29: Last date to drop Winter Term.
Mar. 18: Midterm Test.
Feb. 16 – 19: Winter Term Break (no classes).
Mar. 31: Voluntary withdrawal (VW) deadline.
Apr. 15: Last lecture.
Apr. 19 – May 1: Final exam period.

Respectful Behaviour in Online Classroom

All live components of this course will be conducted over Cisco Webex in UM Learn. It is expected that you conduct yourself professionally and do not distract your fellow students with unnecessary or inappropriate chat messages, sounds, or images if you are ever on web camera. If you appear on web camera it is expected that you will be dressed appropriately for a classroom environment.

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, examination impersonation and typical penalties) can be found at:

http://www.umanitoba.ca/student/resource/student_advocacy/academicintegrity/students/a-to-i-what-is-academic-integrity.html#cheating-on-exams

http://www.umanitoba.ca/student/resource/student_advocacy/academicintegrity/students/student-academic-misconduct-faq.html

https://www.sci.umanitoba.ca/students/undergraduate-students/academic-resources/academic-integrity-2/

This is a remote learning course. I expect students to hold themselves to the highest standards of academic integrity. I expect you to be honest, conduct yourself with integrity, actively encourage your peers to conduct themselves with integrity, and uphold the value of what a degree from the University of Manitoba means. When you are in doubt, always consult with me. My door is always open for discussions. Bear in mind that what is considered a violation of academic integrity can vary from course to course so it is always important to ask and clarify.

Copyrighted Material

Please respect copyright. We may use copyrighted content in this course and ensure that the contents are appropriately acknowledged according to copyright laws and university guidelines. The course notes, assignments, tests and exams are the intellectual property of your instructor or the Department of Statistics. Reproduction or distribution of these materials is strictly forbidden without their consent. You do not have permission to upload any course notes, tests, assignments, or handouts to any note sharing websites. Please see the following site: https://umanitoba.ca/admin/vp_admin/ofp/copyright/media/Note_sharing_Web_sites.pdf. For more information, see the university's copyright office website at http://umanitoba.ca/copyright.

Course Technology

You will require the following minimum technological requirements for this course:
A computing device where one can create and edit documents.
An internet connection capable of streaming videos and downloading software.
Access to a webcam and microphone.

Recording of Class Lectures

Your instructor and the University of Manitoba hold copyright over the course materials, presentations and lectures which form part of this course. No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without permission from your instructor.

Use of Electronics 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. A student may use technology in the classroom setting only for educational purposes approved by the instructor and/or the University of Manitoba Accessibility Services. Students should not engage in electronic messaging/posting activities (e-mail, texting, video or voice chat, social networking (e.g. Facebook) or electronic gaming during scheduled class time.

Class Communication

The University requires all students to activate an official University email account. Please note that all communication between your instructor and you as a student must comply with the Electronic Communication with Students Policy. For more information, please see:
http://umanitoba.ca/admin/governance/governing_documents/community/electronic_communication_with_students_policy.html

You are required to use your U of M email account for all communication between yourself and the university.

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. Schedule A will be posted in UM Learn.

Finally, I would like to repeat that our primary goal will be to reinforce the fundamental concepts, and to have a solid understanding of linear models by the end of the course. Please feel free to ask me whenever you have problem understanding any of the materials. When you are in doubt on anything, please feel free to consult with me. Let us together make this course successful.