

The University of Manitoba
STAT 7140 – Linear Models
Winter Term 2022

Course Outline

Important Note: Like all other University-wide announcements, it is anticipated that the activity plans (be they remote or in-person) for after February 26 may be changed. Activity plans will be communicated by email and will be posted on the University website. While we are online, we will try and mimic the in-person environment as much as possible. **It is now confirmed that this term will continue with remote learning.**

Course Number & Title: STAT 7140, Linear Models.

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

Instructor: Dr. Saumen Mandal
Department of Statistics.
E-mail: saumen.mandal@umanitoba.ca

Office Hours: Thursdays: 12:00 p.m. – 1:00 p.m.
If the above time is not convenient for you, please email me to arrange an alternate time to meet. You can also ask me questions at the end of the class.

Web Pages: UM Learn: <http://umanitoba.ca/umlearn>
Crowdmark: <https://crowdmark.com/>
Statistics: <https://www.sci.umanitoba.ca/statistics>

Calendar Description

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

Textbook and Course Materials

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. If you would like to order the book online, you can go to this link and search by department/course#: <http://bookstore.umanitoba.ca/SelectTermDept>

You can also go to the bookstore and purchase the physical (hard) copy directly from there. Before you go, give them a call to make sure they have the physical (hard) copy in stock.

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. You can have free access to SAS Studio with SAS OnDemand for Academics. This is a free cloud-based software for teaching and learning. No installation is required. After registering, you can start using SAS Studio in a web browser. Homepage of SAS OnDemand for Academics: https://www.sas.com/en_us/software/on-demand-for-academics.html Frequently Asked Questions can be found at: https://support.sas.com/ondemand/caq_new.html

Instructions for Getting Started are given in the SAS web site. Here are the steps:

- Step 1:** Create and verify a SAS profile (use this link: <https://www.sas.com/profile/ui/#/create>) if you don't have one. If you have one, just log in.
- Step 2:** Register (use this link: <https://welcome.oda.sas.com/login>) for SAS OnDemand for Academics using your SAS profile credentials.
- Step 3:** Once you receive a confirmation email, click the link to go to SAS OnDemand for Academics.
- Step 4:** Log in to access SAS Studio.

Please watch this YouTube video on Getting Started with SAS OnDemand:
<https://www.youtube.com/watch?v=tmL8fdOd-pI>

I will give a demo in the class. Instructions will be given in the class. Data sets and SAS code will be posted in UM Learn.

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. You need to create a Crowdmark account (if you don't have one) at the web site: <https://crowdmark.com/> using your U of M email. This email must be the same as you have in UM Learn. 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 on March 22. The syllabus for the midterm test will be the materials covered until March 15. 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 two 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. Both the test and exam will be online in Crowdmark, and will be invigilated via Cisco Webex in UM Learn. You will be required to be on Cisco Webex in UM Learn, 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.

Note: It is now confirmed that this term will continue with remote learning.

Course Evaluation and Grading Scheme

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%).

Goals and Course Contents

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/objective 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. 25: First lecture - course overview.

Feb. 4: Last date to drop Winter Term.

Mar. 22: Midterm Test.

Feb. 22 – 25: Winter Term Break (no classes).

Apr. 25: Voluntary withdrawal (VW) deadline.

Apr. 21: Last lecture.

Apr. 26 – May 3: 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/>

Academic Integrity Message from Associate Dean Krystyna Koczanski: <https://youtu.be/Ok-lilm4SeE>

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 obtain and 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. For more information, please see: <https://umanitoba.ca/student-supports/accessibility>

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/objective 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.

Please find some information from the Faculty of Science in the following pages. Some information may be repeated from the above.

Academic Integrity

Academic integrity is taking responsibility for and being honest with your work and respecting the work of others. Since you are a member of the university community, we want you to learn what that responsibility and honesty entails and how we respect the work of others.

The Faculty of Science continues to uphold high standards of academic integrity. We know that you, our students, support us in this and we count on each and every one of you to do your part. We will continue to ensure no one is using Covid-19 circumstances as a means to gain an unfair advantage over their fellow students. Thus, as with standard in-person examinations, we expect all students to strictly adhere to instructions from their professors regarding what resources can and cannot be used during the exams, to follow other rules the professors wish to set, and to adhere to the academic conduct standards of the University and Faculty.

To aid professors in assuring that all forms of assessments have been administered fairly, the University will be electronically monitoring all tests, quizzes and examinations, included, but not limited to overseeing chat-rooms, relevant predatory web-sites and, in so doing, we will analyze scholastic evidence of individual exams.

Please view information with regards to academic integrity: **be aware; be proactive; be smart and be honest.**

Academic Integrity Message from Associate Dean Krystyna Koczanski: <https://youtu.be/Ok-lilm4SeE>

The Student Discipline By-Law may be accessed at:

http://umanitoba.ca/admin/governance/media/Student_Discipline_Bylaw_-_2009_01_01.pdf

The list of suggested minimum penalties assessed by the Faculty of Science for acts of academic dishonesty is available on the Faculty of Science webpage:

http://umanitoba.ca/faculties/science/resources/Acad_Dishon_TABLE_RevCSS_AdminC_Jul2012_WEB.pdf

All Faculty members (and their teaching assistants) have been instructed to be vigilant and report all incidents of academic dishonesty to the Head of the Department.

<https://universityofmanitoba.desire2learn.com/d2l/le/content/6606/viewContent/1463719/View>

How to succeed in your science courses?

The Faculty of Science is committed to delivering the high quality education our students have come to expect. We also want to ensure that you set yourself up for success. We want you to succeed!

#1. We recommend that you consider the stated requirements of this course.

While we are making reasonable accommodations for students, you will want to plan ahead accordingly and be flexible.

#2. Use the [Registration Revision Period](#) to evaluate the course syllabus, and the course content. Some courses will have interactive activities and assessments such as tutorials, online labs, and online quizzes at scheduled times throughout the term in addition to/in lieu of examinations. Make sure that your current situation will allow you to participate in all courses to the fullest. ***This is particularly important for students who will be joining us from different time zones.***

Some courses may have a mandatory on-campus component. Student safety is very important to us and the University of Manitoba, operating in close collaboration with Manitoba Public Health, has authorized these components. The primary aim of our in-person components is to maximize the education and training of our students whose future is at risk without it. The University of Manitoba is implementing many safety measures to ensure the safety of students and staff while on campus, such as requiring face masks (three-ply disposable ones), proper hand hygiene, physical distancing, and sanitation of high-touch surfaces with ethanol solution or disinfectant wipes to help mitigate the risks associated with contracting COVID-19.

If you know that you will be unable to participate in an on-campus component because, for example, you are not currently in Winnipeg and are unable to come to Winnipeg, you, or someone you live with, is immunocompromised, or you are simply uncomfortable with attending, you are strongly urged to withdraw from the course during the Registration Revision Period.

Note: *during the registration revision period you will be able to drop/add courses without any financial consequence.* Speak directly with instructors if you have any questions specific to their course.

#3. Take time to consider the workload associated with the course schedule you are planning. Remote learning has its challenges and your ability to adapt and be flexible in this context is very important. Be realistic about other commitments and distractions that are part of everyday life, and make your course selection decisions accordingly. If you want to discuss anything, the academic advisors are available – email: sciadv@umanitoba.ca to request an appointment.

LEARNER SUPPORT

Writing and Learning Support

The Academic Learning Centre (ALC) offers writing and learning supports to help you throughout your academic program. These supports are offered online during the Covid-19 pandemic.

Make an appointment with an ALC writing tutor who can give you feedback at any stage of the writing process, whether you are just beginning to work on a written assignment or already have a draft. The ALC also has an English as an Additional Language (EAL) specialist available to work with students on improving their English-language academic writing skills.

Consult an ALC learning specialist or attend an academic skills workshop to improve your time management, learning strategies and test-taking strategies. Get support in select courses by making an appointment with an ALC content tutor. The ALC also offers peer-facilitated study groups called Supplemental Instruction (SI) for certain courses that students have typically found difficult. In SI study groups, students ask questions, compare notes, discuss content, solve practice problems, and develop new study strategies in a group-learning format.

In addition to one-to-one and group sessions, you can also find writing and study tip sheets and videos on the ALC website.

Academic Learning Centre services are free for U of M students. For more information, please visit the Academic Learning Centre website at: <http://umanitoba.ca/student/academiclearning/>

Contact the Academic Learning Centre by calling 204-480-1481 or emailing academic_learning@umanitoba.ca.

University of Manitoba Libraries (UML)

Research begins at [UM Libraries](#). [Learn at the Libraries](#) is a great place to start, with information for students on academic writing, how to search the library, evaluating resources, and writing citations. As the primary contact for all research needs, your [liaison librarian](#) can play a vital role when completing academic papers and assignments. Liaisons can answer questions about locating appropriate resources or managing citations, and will address any other concerns you may have regarding the research process. Liaisons can be contacted by email or phone, and are also available to meet with you online. When working remotely, students can also receive help online through [Ask Us!](#) chat. For further detail about the libraries' services and collections, [visit the Libraries' web site](#). Regularly check our [COVID-19 Update](#) page for available library services and access to resources.

For 24/7 mental health support, contact the Mobile Crisis Service at 204-940-1781.

Student Counselling Centre

Contact SCC if you are concerned about any aspect of your mental health, including anxiety, stress, or depression, or for help with relationships or other life concerns. SCC offers crisis services as well as

individual, couple, and group counselling. *Student Counselling Centre:*

<http://umanitoba.ca/student/counselling/index.html>

474 UMSU University Centre or S211 Medical Services Building, (204) 474-8592

Student Support Case Management

Contact the Student Support Case Management team if you are concerned about yourself or another student and don't know where to turn. SSCM helps connect students with on and off campus resources, provides safety planning, and offers other supports, including consultation, educational workshops, and referral to the STATIS threat assessment team.

<http://umanitoba.ca/student/case-manager/index.html>

520 UMSU University Centre

(204) 474-7423 (Student Support Intake Assistant)

University Health Service

Contact UHS for any medical concerns, including mental health problems. UHS offers a full range of medical services to students, including psychiatric consultation.

University Health Service <http://umanitoba.ca/student/health/>

(204) 474-8411 (Business hours or after hours/urgent calls)

Health and Wellness

Contact our Health and Wellness Educator if you are seeking information on health topics, including physical and mental health concerns, alcohol and substance use harms, or sexual violence. You can also access peer support from a *Healthy U* peer health educator.

Health and Wellness Educator

<https://umanitoba.ca/student/health-wellness/welcome-about.html>

britt.harvey@umanitoba.ca

469 UMSU University Centre

(204) 295-9032

Sexual Violence Resource Centre (SVRC)

Contact SVRC if you have experienced sexual violence or are seeking information about how to help somebody else. SVRC provides inclusive, survivor-centred, trauma-informed services, such as consultation, referrals, safety planning, and a range of on-site supports, including counselling by Klinik.

Sexual Violence Resource Centre

<https://umanitoba.ca/student-supports/sexual-violence-support-and-education>

svrc@umanitoba.ca

537 UMSU University Centre

(204) 474-6562 (Sexual Violence Intake and Triage Specialist)

Your rights and responsibilities

As a student of the University of Manitoba you have rights and responsibilities. It is important for you to know what you can expect from the University as a student and to understand what the University expects from you. Become familiar with the policies and procedures of the University and the regulations that are specific to your faculty, college or school.

The [Academic Calendar](http://umanitoba.ca/student/records/academiccalendar.html) <http://umanitoba.ca/student/records/academiccalendar.html> is one important source of information. View the sections *University Policies and Procedures* and *General Academic Regulations*.

Grade Appeals

If you have questions about your grades, talk to me. There is a process for term work and final grade appeals. Note that you have the right to access your final examination scripts. See the Registrar's Office website for more information including appeal deadline dates and the appeal form <http://umanitoba.ca/registrar/>

Academic Integrity

You are expected to view the General Academic Regulation section within the Academic Calendar and specifically read the Academic Integrity regulation. Consult the course syllabus or me for additional information about demonstrating academic integrity in your academic work. Visit the Academic Integrity Site for tools and support <http://umanitoba.ca/academicintegrity/> View the Student Academic Misconduct procedure for more information.

Violent or Threatening Behaviour

http://umanitoba.ca/admin/governance/governing_documents/community/669.html

Sexual Assault

If you experience Sexual Assault or know a member of the University community who has, it is important to know there is a policy that provides information about the supports available to those who disclose and outlines a process for reporting. The Sexual Assault policy may be found at:

http://umanitoba.ca/admin/governance/governing_documents/community/230.html

More information and resources can be found by reviewing the Sexual Assault site

<http://umanitoba.ca/student/sexual-assault/>

Intellectual Property

For information about rights and responsibilities regarding Intellectual Property view the policy:

https://umanitoba.ca/admin/governance/governing_documents/community/235.html

For information on regulations that are specific to your academic program, read the section in the Academic Calendar and on the respective faculty/college/school web site <http://umanitoba.ca/faculties/>

Academic Program Questions

Contact an Academic Advisor within our faculty/college or school for questions about your academic program and regulations <http://umanitoba.ca/academic-advisors/>

Student Advocacy

Contact Student Advocacy if you want to know more about your rights and responsibilities as a student, have questions about policies and procedures, and/or want support in dealing with academic or discipline concerns. <http://umanitoba.ca/student/advocacy/>

520 University Centre

204 474 7423

student_advocacy@umanitoba.ca

Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. University guidelines state that copyrighted works, including those created by instructors of the course are made available for private study and research and must not be distributed in any format without permission. Since it is illegal, do not upload copyrighted works to a learning management system (such as UM Learn), or any website, unless an exception to the Copyright Act applies or written permission has been confirmed. All students are required to respect copyright as per Canada's *Copyright Act*. Staff and students play a key role in the University's copyright compliance as we balance user rights for educational purposes with the rights of content creators from around the world. The Copyright Office provides copyright resources and support for all members of the University of Manitoba community. For more information, see the University's Copyright Office website at <http://umanitoba.ca/copyright/> or contact um_copyright@umanitoba.ca