

STAT 2220
Contemporary Statistics for Engineers
Winter 2024

Time Mondays, Wednesdays & Fridays, 1:30 p.m. – 2:20 p.m.
Location 200 Fletcher Argue
CRN 50089

Instructor Dr. Ankit Doshi (He/Him)
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Web Pages UM Learn: <http://umanitoba.ca/umlearn>
R Download (Windows): <https://muug.ca/mirror/cran/bin/windows/>
R Download (MacOS): <https://muug.ca/mirror/cran/bin/macosx/>
R Studio: <https://www.rstudio.com/products/rstudio/#download>
iClicker Student: <https://student.iclicker.com>

Office Hours: Mondays 10:00 a.m. – 11:00 a.m.
Wednesdays 10:00 a.m. – 11:00 a.m.
Thursdays 12:00 p.m. – 1:00 p.m.

(or by appointment, excluding university holidays, through April 10)

Office hours are drop-in. You do not need an appointment; simply come to my office at the indicated time if you'd like to meet with me.

If the above times are not convenient for you, please contact me to arrange an alternate time to meet. I will do my best to return all email or telephone messages within 24 hours.

Territory Acknowledgment

The University of Manitoba campuses are located on original lands of Anishinaabeg, Cree, Oji-Cree, Dakota and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Calendar Description

(Lab Required) Descriptive statistics, basic probability concepts, special statistical distributions, statistical inference-estimation and hypothesis testing, regression, reliability, statistical process control. May not be held with STAT 1000, STAT 1001 or STAT 1150. Prerequisite: one of MATH 1232, MATH 1700, MATH 1701, MATH 1710.

Course Objectives

Upon completion of this course, the student will have an understanding of the fundamental concepts of statistics and an appreciation for the application of statistics in the field of Engineering.

Evaluation

iClicker Tutorials (best 4 of 5)	8%
Assignments (best 3 of 4)	12%
Term Test 1*	15% or 20%
Term Test 2*	15% or 20%
Final Examination	45%

*Your better term test will be worth 20% of your final grade; the other will be worth 15%.

If you miss a second assignment or a second iClicker tutorial due to illness or another valid reason, **and provided that you have submitted a self-declaration form to your instructor within 24 hours of both missed due dates**, the weight will be transferred to your final exam. (See Page 13 of the syllabus for an explanation and link to the required form.)

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

Textbook

There is **no required textbook** for this course. You will be provided with detailed notes and all the material you need.

Exam Information

The first term test will be held **Thursday, February 15 from 1:00 p.m. to 2:15 p.m.** and will cover Units 1 – 4 in the course notes. The second term test will be held **Thursday, March 21 from 1:00 p.m. to 2:15 p.m.** and will cover Units 5 & 6 in the course notes. Students missing a test for a valid reason will be permitted to write a deferred test at a later date. The final exam will be 3 hours in duration and will be scheduled by the Registrar's Office. The final exam will cover Units 1 – 8, with emphasis on material covered after the second term test.

Both the term tests and the final examination will contain multiple-choice questions and a written component.

Both the term tests and the final exam are **closed book**. However, you will be provided with a formula sheet and, if required, statistical tables.

For tests and exams, you will also need a **non-programmable scientific calculator**. (Graphing calculators are **not** permitted.)

Software

This course will make use of the statistical software R and RStudio. Both of these programs are free to use and are available for both Windows and MacOS systems. R is one of the most popular statistical software programs, and throughout the course, we will utilize R to help with our data analysis. We will use R through the RStudio environment, which will neatly organize and display your work. Finally, RMarkdown (a component of RStudio) will be used to format the assignments that you submit.

To download R, follow one of the links below (depending on your operating system):

Windows systems: <https://muug.ca/mirror/cran/bin/windows/>

MacOS systems: <https://muug.ca/mirror/cran/bin/macosx/>

Once you have downloaded and installed R, you may access RStudio through the link below:

<https://posit.co/download/rstudio-desktop/>

Detailed installation instructions will be provided on your *UM Learn* page.

Tutorials and Assignments

Thursdays, 1:00 p.m. – 2:15 p.m., 408 Tier

Your first tutorial will be January 11. (There are no tutorials during the Winter Term Break, or the weeks of the two term tests.) There will be two different types of tutorial: R tutorials and iClicker tutorials.

In the first **R tutorial**, your T.A. will introduce you to R and RStudio, and show you what the software looks like. However, it is expected that you will have R and RStudio installed prior to your first tutorial, and that you will have RMarkdown set up. There will be a detailed installation and setup guide on your *UM Learn* page. Subsequent R tutorials will consist of the T.A. going over the application of the R statistical software to course material that has been recently covered in class. The T.A. will complete the beginning of your assignment in detail. Some assignment questions will require the use of R; others will be written-answer questions, which require you to show your work and calculations.

There will be four assignments in the course. Part of each assignment (the questions involving R) will be formatted with RMarkdown, and submitted to Crowdmark for grading. For written-answer questions, you will submit pictures or scanned copies of your work. Only the best 3 of 4 assignment grades will count towards your final grade (i.e., the lowest grade will be dropped, which means you can miss one assignment with no penalty).

If you can, you should **bring a laptop to your R tutorials**. Note that whatever machine you bring must be able to run R and RStudio; this means either a Windows computer (running Windows 10/11) or a MacOS computer (running MacOS 10.15 or higher); most tablets and Chromebook will not be sufficient. If you do not have access to a machine that can run RStudio, you may either use one of the computers in 311 Machray Hall or borrow a laptop from the lending locker at the Elizabeth Dafoe Library (see <https://umanitoba.ca/libraries/laptops>).

For the assignments:

- You may speak to your classmates, but you may not directly show your code/output to anyone. To be clear, you can help a classmate by directing them to a similar example in the notes or tutorial files, but you can not look directly at someone else's work or show them your work.
- Sharing your work or R code with someone, either directly or online (such as in a Telegram chat room) will be considered an act of academic dishonesty, as will copying someone else's work, or allowing someone to copy yours.
- Each student must submit their own assignment.
- If you need help with an assignment, please use the Statistics Help Centre, where there are graduate students in Statistics available to help you. (See the schedule on Page 6.)

In the **iClicker tutorials**, the iClicker classroom response system will be used in order to enhance your understanding of the material and promote participation. Your T.A. will go through multiple-choice iClicker questions. Each iClicker question will be worth two marks; you will be awarded one mark just for answering (a participation mark), and one additional mark if you get the correct answer. Each tutorial will be weighted equally and only the **best 4 of 5** iClicker tutorial grades will count towards your final grade (i.e., the lowest grade will be dropped, which means you can miss one iClicker tutorial with no penalty). **You should bring your cell phone or an internet enabled device that runs a web browser or the iClicker Student app to each class. You can use a laptop, iPhone/iPad (iOS 10+), or Android (OS 5.0+) device.**

You will need to make a free iClicker Student account either through their app or their website, <https://student.iclicker.com>. Once registered, you will need to add your tutorial section for this class in your app or web profile.

For the iClicker tutorials:

- When the TA puts a question up, you are permitted to discuss the question and answer with your classmates. (iClicker tutorials are not intended to be “tests”; they are intended to help you review the previous week’s material and assess your understanding.)
- You must be present in your tutorial to participate with the iClicker questions. Answering questions while not present in your tutorial will be considered an act of academic dishonesty.
- While questions are being asked, you may **not** discuss them with anyone by text or online. Sharing answers or discussing questions by text or online (such as in a Telegram chat room) will be considered an act of academic dishonesty.

Practice Questions

You will be provided with many practice questions in this course. In the **Practice Problems** folder on *UM Learn*, you will find written-answer questions for each unit, as well as detailed solutions. These problems will help you practice and learn the course material, and to prepare for the long-answer questions on the term tests and final exam.

In the **Practice Multiple Choice Questions** folder on *UM Learn*, you will find many multiple choice questions for each unit. The letter answers for these questions are at the end of each file. These questions will help you practice and learn the course material, and to prepare for the multiple choice questions on the term tests and final exam.

Although they are not for marks, students are strongly encouraged to try these practice problems on a regular basis.

Statistics Help Centre

In 107 Allen Building, graduate students and senior undergraduate students in Statistics are available to help you with any questions you have about the course, as well as the installation of R and RStudio. The Help Centre is open starting on January 10 (except on days when the university is closed and during the Winter Term Break) at the following times:

Monday	10:00 a.m. – 5:00 p.m.
Tuesday	10:00 a.m. – 7:00 p.m.
Wednesday	10:00 a.m. – 5:00 p.m.
Thursday	10:00 a.m. – 5:00 p.m.
Friday	10:00 a.m. – 5:00 p.m.
Saturday	1:00 p.m. – 5:00 p.m. (online at https://umanitoba.zoom.us/j/63661229764)

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 on your instructor's UM Learn page.

STAT 2220 Course Schedule

Week	Dates	Tutorials	Assignment Due Dates
Week 1	Jan. 8 – Jan. 12	Tutorial 1	TA Demonstration
Week 2	Jan. 15 – Jan. 19	Tutorial 2	TA Demonstration
Week 3	Jan. 22 – Jan. 26	Tutorial 3	iClicker Assignment 1 due January 25
Week 4	Jan. 29 – Feb. 2	Tutorial 4	TA Demonstration
Week 5	Feb. 5 – Feb. 9	Tutorial 5	iClicker Assignment 2 due February 8
Week 6	Feb. 12 – Feb. 16	Tutorial 6	Test 1 February 15 Units 1 – 4
Winter Term Break	Feb. 19 – Feb. 23	No Tutorial	
Week 7	Feb. 26 – Mar. 1	Tutorial 7	iClicker
Week 8	Mar. 4 – Mar. 8	Tutorial 8	TA Demonstration
Week 9	Mar. 11 – Mar. 15	Tutorial 9	iClicker Assignment 3 due March 14
Week 10	Mar. 18 – Mar. 22	Tutorial 10	Test 2 March 21 Units 5 & 6
Week 11	Mar. 25 – Mar. 29 No class March 29 (Good Friday)	Tutorial 11	TA Demonstration
Week 12	Apr. 1 – Apr. 5	Tutorial 12	iClicker Assignment 4 due April 4
Week 13	Apr. 8 – Apr. 10	No Tutorial	

Course Outline

Unit 1 – Examining Distributions

- types of variables: quantitative, categorical (nominal, ordinal)
- graphs: bar charts, pie charts, frequency distributions, histograms, time plots
- examining distributions, shape (skewed, symmetric)
- describing distributions with numbers: mean, weighted mean, median, quartiles, percentiles, interquartile range, range, variance and standard deviation
- five-number summary and quantile boxplots
- outliers
- the $1.5 \times \text{IQR}$ rule for suspected outliers, outlier boxplots
- resistant measures

Unit 2 – Examining Relationships

- association, explanatory variable, response variable
- examining scatterplots
- correlation
- least squares criterion and least squares regression line, prediction
- slope, intercept, r^2
- residuals
- outliers, influential observations
- association vs. causation, lurking variables
- extrapolation

Unit 3 – Sampling & Experimental Design

- populations and samples
- voluntary response sample, convenience sample
- simple random sample
- stratified random sample
- multistage sample
- systematic sample
- census
- undercoverage, nonresponse
- observational study vs. experiment
- factors, factor levels, treatments
- placebo effect, control group
- principles of experimental design
- completely randomized design
- randomized block design

Unit 4 – Probability Theory

- randomness, definition of probability
- sample space, outcomes, events
- basic probability rules
- mutually exclusive events, exhaustive events, complements
- conditional probability
- independence
- Law of Total Probability, Bayes' Theorem
- system reliability

Unit 5 – Random Variables

- discrete random variables (probability mass function, cumulative distribution function)
- continuous random variables (probability density function, cumulative distribution function)
- expected value and variance of a random variable
- functions of random variables

Unit 6 – Common Discrete and Continuous Distributions

- Bernoulli random variables, binomial distribution
- geometric and negative binomial distribution
- hypergeometric distribution
- Poisson distribution
- continuous uniform distribution
- Exponential distribution (relationship with Poisson distribution, lack-of-memory property)
- normal distribution

Unit 7 – Sampling Distributions

- sampling distribution of a sample mean
- Central Limit Theorem
- sampling distribution of a proportion

Unit 8 – Inference for a Single Population

- estimating with confidence
- confidence interval for a population mean (σ known)
- margin of error
- effect of sample size, confidence level, standard deviation
- effect of population size
- sample size calculation for estimating a population mean
- hypothesis tests for a population mean (σ known)
- hypotheses, test statistic, P -value, statistical significance
- two-sided tests and confidence intervals
- confidence intervals and hypothesis tests for a population mean (σ unknown)
- confidence intervals and hypothesis tests for a population proportion
- sample size calculation for estimating a population proportion

Academic Integrity

It is important that you understand what constitutes academic dishonesty and that you are familiar with the very serious consequences. The following link describes various types of academic dishonesty (including plagiarism, cheating, inappropriate collaboration and examination impersonation), and offers several resources to help students understand and avoid academic dishonesty:

<http://umanitoba.ca/student-supports/academic-supports/academic-integrity>

The Student Discipline Bylaw, which describes the potential consequences of academic dishonesty, can be found at the following link:

https://umanitoba.ca/governance/sites/governance/files/2021-09/Student%20Discipline%20Bylaw%20-%202021_09_01.pdf

An academic integrity and student conduct tutorial can be found at the following link. For this course, it is recommended in particular that you view the parts on Tests & Exams and Inappropriate Collaboration.

http://umanitoba.ca/student/resource/accessibility/files/AI-Student-Conduct-Tutorial/story_html5.html

The use of generative artificial intelligence (genAI) tools and apps is strictly prohibited for all assessments (including assignments) in this course. This includes ChatGPT and other AI writing and coding assistants. Use of genAI in this course constitutes an act of academic dishonesty.

Copyrighted Material

All course notes, assignments, tests, exams, practice questions and solutions are the intellectual property of your instructor or the Department of Statistics. **The reproduction, posting or distribution of these materials is strictly forbidden without their consent.** It is **illegal** to upload any course material to any website. For more information, see the University's Copyright Office website at <http://umanitoba.ca/copyright>.

Recording of Class Lectures

Your instructor holds 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** without permission from your instructor.

Class Communication

The University requires all students to activate an official University email account. Please note that all communication between you and your instructor must comply with the Electronic Communication with Students Policy. 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.

Voluntary Withdrawal

The voluntary withdrawal date is **March 20** (by which time you will have received your marks for the first term test, your first four iClicker tutorials, and at least two assignments). If you are unlikely to be successful in the course, or are not achieving the grade that you are aiming for, you should consider a VW from the course. Students enrolled in the course after the VW deadline will be assigned a final grade.

Authorized Withdrawal

In some instances, medical or compassionate circumstances arise in a student's life that prevent them from performing as they would in normal circumstances. If you are in this position, please contact a Faculty academic advisor to discuss your options. Be prepared to provide documentation, which supports your situation.

Health and Safety

The University of Manitoba is committed to maintaining a safe learning environment for all students, faculty, and staff. Should campus operations change because of health concerns related to a pandemic or other campus-wide emergency, it is possible that this course will move to a fully remote delivery format. Should the instructor be required to stay at home for an extended period and an alternate instructor not be available, the course may move temporarily to a remote delivery format.

Illness

Remember: **Stay home if you are sick.** Your lowest assignment mark and your lowest iClicker tutorial grade will be dropped. **The purpose of this policy is that we know you may be unable to complete an assessment sometime during the term, either due to illness or some other valid reason.** Please complete the self-declaration form (see Page 13) if you have to miss an assessment.

Academic Accommodations

Student Accessibility Services

Students who have, or think they may have, a disability (e.g., mental illness, learning, medical, hearing, injury-related, visual) are encouraged to contact Student Accessibility Services to arrange a confidential consultation. Instructors are notified by Student Accessibility Services what accommodations their registered students require, which will help the instructor determine fair, feasible and reasonable academic accommodations without compromising academic standards. This takes time and planning, so reach out at the start of term.

SAS students can write their exams and tests in spaces organized by the SAS Exam Centre; however, they must register with the SAS Exam Centre a few weeks in advance. Please be sure to do so to receive the accommodations.

Student Accessibility Services

<http://umanitoba.ca/student-supports/accessibility>

520 University Centre

204-474-7423

Student.accessibility@umanitoba.ca

Medical Notes and Other Documentation

The Self-Declaration for Brief and Temporary Absences Procedure and Policy will be effective on September 1, 2022 and therefore students will not be required to present medical or other documentation for absences due to extenuating circumstances of five days (120 hours) or less; however, you must complete the form at the following link:

<https://umanitoba.ca/sites/default/files/2022-09/Self%20Declaration%20Fillable%20Form-%20FINAL%20for%20Website.pdf>

You must submit the form to your instructor in lieu of any medical or other documentation. Please note that further documentation may be requested from students who claim multiple temporary absences or absences for more than five days. You only need to submit this form if you miss an assessment. You do **not** need to fill out this form if you are missing a lecture or a tutorial. Note that personal vacations or work obligations are **not** considered valid excuses to miss assessments.

Final Exams

If you have conflicting scheduled final exams, or if you miss a final exam due to illness or some other valid reason, **you must contact an academic advisor in your home faculty** (<http://umanitoba.ca/academic-advisors/>) as soon as possible to apply for a deferred exam. Deferred final exams are **not** arranged through your instructor or the department. Note that the granting of a deferred exam is not necessarily guaranteed.