STAT 230 - Probability
Spring 2022
Course Syllabus

Course Website:

Please login to learn.uwaterloo.ca You are expected to regularly read your UWaterloo e-mail and visit the course website on LEARN for Announcements.

Instructors:

Sec	Instructor	Email	Lecture Times	Room
001	James Adcock	jradcock@uwaterloo.ca	2:30 – 3:20 MWF	RCH 101
002	Erik Hintz	ehintz@uwaterloo.ca	11:30 – 12:20 MWF	EXP 1689
003 (CS)	Jeremy VanderDoes	jeremy.vanderdoes@uwaterloo.ca	10:30 – 11:20 MWF	STC 0010

Tutorial Times: Mondays 9:30 – 10:20 DC 1350, 10:30 – 11:20 EXP 1689, and 11:30 – 12:20 STC 0010

Weekly Office Hours: No regular office hours will be held. Please use Piazza for Q&A.

If you need to communicate with your Instructor directly for other / personal reasons, please send an e-mail.

Course Notes:

STAT 220/230/240 Course Notes (Spring 2022 Edition) by Chris Springer (revised by Jerry Lawless, Don McLeish and Cyntha Struthers) are posted on LEARN, and are available at the University Bookstore. These Course Notes are designed to complement the material covered in lectures.

Course Description:

This course provides students with an introduction to probability models including sample spaces, mutually exclusive and independent events, conditional probability and Bayes' Theorem. The named distributions (Discrete Uniform, Hypergeometric, Binomial, Negative Binomial, Geometric, Poisson, Continuous Uniform, Exponential, Normal (Gaussian), and Multinomial) are used to model real phenomena. Discrete and continuous univariate random variables and their distributions are discussed. Joint probability functions, marginal probability functions, and conditional probability functions of two or more discrete random variables and functions of random variables are also discussed. Students learn how to calculate and interpret means, variances and covariances particularly for the named distributions. The Central Limit Theorem is used to approximate probabilities.

Course Objectives:

- To provide students with a basic understanding of probability, random variables and expectation.
- To provide students with knowledge of the physical setups for the named distributions including the Hypergeometric, Binomial, Negative Binomial, Geometric, Poisson, Uniform, Exponential and Normal.

Pre-requisites:
To take this course, you need: (one of MATH 116, 117, 137, 147 with a minimum grade of 80%) or (MATH 128 with a minimum grade of 60%) or (one of MATH 118, 119, 138, 148).

Anti-requisites: STAT 220, STAT 240.

Post-requisite:
STAT 231 relies very heavily on the concepts from STAT 230. It is recommended that you take STAT 231 as soon as possible after completing STAT 230. To move to STAT 231, you only need a pass (50%) in STAT 230. **However, to take upper-year STAT courses such as 330, 333, 334, or 340, you need 60% in STAT 230.**

Learning Outcomes:
Upon successful completion of this course, you will be able to:

- define a probability model and determine probabilities of events using counting techniques;
- distinguish between mutually exclusive and independent events, and calculate conditional probabilities using Bayes' theorem;
- distinguish between discrete and continuous random variables;
- define and use probability functions/probability density functions and cumulative distribution functions to determine probabilities of events;
- define and use joint probability functions, marginal probability functions, and conditional probability functions to determine the probabilities of events for two or more discrete random variables;
- use the named distributions (Discrete Uniform, Hypergeometric, Binomial, Negative Binomial, Geometric, Poisson, Continuous Uniform, Exponential, Normal (Gaussian), and Multinomial) to model real phenomena;
- calculate and interpret means, variances and covariances particularly for the named distributions;
- define the Central Limit Theorem and use it to approximate probabilities;
- find moment generating functions for the named distributions and use the moment generating function to determine expectations.

Missed Lectures:
If you miss lectures, then you are responsible for reaching out to a classmate in order to find out what was missed. Also, please note that Instructors may annotate lecture slides during class time, but these annotations will **not** be available on LEARN after the lecture.

Calculator Policy:
For the tests and final exam, only a non-programmable, non-graphical, Math faculty approved calculator with a pink-tie or blue goggle sticker will be allowed.

Remarking of Tests:
If you have a question regarding the marking of a test, you must first check the posted solutions. If you still have a question, then you should follow the procedure which will be posted on the course website following each test. From the time a test is returned to you, **you have one week to appeal a test grade (no exceptions will be made for any reason).**

Out-of-Class Workload:

As in any University course, much of your learning in this course will take place outside of class time. Each week you have 3 hours of lectures. Therefore, you should plan to spend 3-6 hours each week in out-of-class learning. This learning consists mostly of making sure you understand the concepts and steps that were used in class to solve problems and then solving problems from the Course Notes on your own.

Grading Scheme:

Every student (regardless of section) is treated the same way according to the grading scheme below. We cannot modify final grades to give someone an extra percent – this would be unfair to the other students.

Note: There are 2 grading schemes in order to minimize the impact of a poor performance on either of the 2 Term Tests:

Scheme 1

Tutorial Quizzes (best 3 of 6):	15% (5% each)
Term Test 1:	17.5%
Term Test 2:	17.5%
Final Exam:	50%

Scheme 2

Tutorial Quizzes (best 3 of 6):	15% (5% each)
Best Term Test:	25%
Worst Term Test:	10%
Final Exam:	50%

Students must write <u>BOTH</u> Term Tests in order to qualify for Scheme 2. Otherwise, Scheme 1 will automatically be used. (See below for how your final grade is determined if you miss any Term Tests.) A student's final grade is the maximum of the two grades calculated using Scheme 1 and Scheme 2.

Tutorials:

When tutorial quizzes are not being held, some tutorials will be used to go over questions in order to get some more practice. Doing these questions can help extend your knowledge and understanding of the concepts taught in class. These tutorials are not mandatory, but solutions will not be posted on LEARN and similar questions could possibly appear on a test and/or the Final Exam. There will also be a tutorial dedicated to learning some of the basics in R.

Tutorial Quizzes:

Please check your schedule for your assigned tutorial time. There will be 6 Tutorial Quizzes held during your scheduled tutorial time. See the course schedule below. **You may only write your Tutorial Quiz in your assigned tutorial time slot.**

Term Tests:

There will be 2 Term Tests on the following dates:

Term Test 1: Tuesday, May 31st from 4:30 - 6:20 p.m.
Term Test 2: Tuesday July 5th from 4:30 - 6:20 p.m.

Final Examination:

A 2.5 hour final cumulative examination will be held during the final exam period, which runs from July 29th to August 13th.

***** Please do not make any travel plans before the final exam schedule is posted.**

Information regarding the tutorial quizzes, term tests, and final exam (e.g. material covered and locations) will be posted on the course website on LEARN.

Students must present a valid Student ID card to write all quizzes, tests and the final exam.

Missed Tutorial Quizzes, Midterm Tests or Final Exam:

If you miss a ***Tutorial Quiz*** due to illness or extenuating circumstances, a grade of 0 will be awarded for that quiz, and this will count as a dropped quiz. You may drop a maximum of three tutorial quizzes.

If you miss a ***Term Test*** due to illness or extenuating circumstances, you must inform your Instructor within 48 hours of the missed Term Test. For a missed Term Test with proper documentation, the weight will be shifted to the Final Exam.

If you miss the ***Final Exam*** due to illness or extenuating circumstances, you must inform your Instructor within 48 hours of the Final Exam. If you miss the Final Exam with proper documentation, then the Mathematics Faculty INC Grade Policy (see below) will apply. Normally, if you have not earned a passing grade on your term work and you do not write the Final Exam, then you will receive a mark of DNW for the course.

Missed Term Tests without proper documentation are automatically awarded a grade of 0.

If you miss both Term Tests (regardless of documentation), you will automatically receive a grade of DNW. Therefore, you should withdraw from the course if this situation applies to you. (In other words, you must write at least one of the scheduled Term Tests).

In the case of illness, you must first provide a completed University of Waterloo Verification of Illness Form (VIF) to the Math Undergraduate Office, **MC 4022.** Remember that you must also inform your Instructor within 48 hours of a missed Term Test or Final Exam.

See: https://uwaterloo.ca/math/vif-submission

In the case of extenuating circumstances, you must provide sufficient documentation to your Instructor as soon as possible to verify the circumstances.

University of Waterloo and Mathematics Faculty Policies

All instructors and students must follow the following academic policies:

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

Mathematics Faculty INC Grade Policy: A grade of INC is awarded to a student who has completed course work during the term well enough that they could reasonably be expected to earn a passing mark in the course, but who was unable to complete end-of-term course requirements (usually the final exam) for reasons beyond their control. See: https://uwaterloo.ca/math/current-undergraduates/regulations-and-procedures/incomplete-procedure

Note for students with disabilities: AccessAbility Services, (AAS) located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

Counselling Services and the Student Success Office: If you need some help during the term with study skills or dealing with personal issues, please make use of the resources that are available to help you. The Student Success Office's mandate is to provide and facilitate strategic student support for academic and personal success. It is located on the second floor of South Campus Hall and you can reach them by email at success@uwaterloo.ca. Counselling Services has offices in MC and many other buildings on campus, in addition to their main offices in the Needles Hall expansion and in Health Services. Find more information about their services here: https://uwaterloo.ca/counselling-services/services

Course Schedule:

The following table gives a **tentative** schedule for the material you are responsible for, along with sections in the Course Notes indicated.

Notes:
We strongly encourage you to do the end-of-chapter questions for more practice / preparation for tests and quizzes.
The weeks for tutorials, tutorial quizzes, and term tests are also indicated.

Week	Topics	Sec.	Notes
1. May 2 – 6	Register for Piazza Course Outline Definitions of Probability Chapter 1 Problems Experiment, Sample Space, Simple and Compound Events, Probability Distribution, Probability of an Event Chapter 2 Problems Addition and Multiplication Rules	 1.1 1.2 2.1 2.2 3.1	No Tutorials
2. May 9 - 13	Counting Arrangements or Permutations Counting Subsets or Combinations Number of Arrangements When Symbols are Repeated. Examples – Extra Practice Chapter 3 Problems	3.2 3.3 3.4 3.5 3.7	**Tutorial Quiz 1** **Note: Section 3.6 – Make sure you review this section – Useful Series and Sums**
3. May 16 - 20	General Methods Rules for Unions of Events, Mutually Exclusive Events Intersection of Events and Independence Conditional Probability	4.1 4.2 4.3 4.4	**Tutorial Quiz 2**
4. May 23 - 27	Product Rule, Law of Total Probability and Bayes' Theorem Chapter 4 Problems Discrete Random Variables and Probability Functions and Their Properties, Cumulative Distribution Functions and Their Properties	4.5 4.6 5.1	**Note:** No classes or tutorials will be held on Monday May 23rd (Victoria Day)
5. May 30 - June 3	Discrete Uniform Distribution Hypergeometric Distribution Binomial Distribution Negative Binomial Distribution Geometric Distribution	5.2 5.3 5.4 5.5 5.6	**Open Tutorial - TBA** **Term Test 1** **Tuesday May 31st** **4:30 to 6:20 p.m.**
6. June 6 – 10	Poisson Distribution from Binomial Poisson Distribution from Poisson Process Combining Other Models with the Poisson Process Summary of Discrete Distributions – Very Helpful for Review! Chapter 5 Problems	5.7 5.8 5.9 5.10 5.11	**Open Tutorial - TBA**
7. June 13 - 17	Summarizing Data on Random Variables Expectation of a Random Variable, Expectation of a Function of a Random Variable, Properties of Expectation Some Applications of Expectation	7.1 7.2 7.3	**Tutorial Quiz 3**

8. June 20 - 24	Means and Variances of Distributions Chapter 7 Problems General Terminology and Notation for Continuous Random Variables – Cumulative Distribution Function and Its Properties, Probability Density Function and Its Properties, Change of Variable. Expectation, Mean and Variance	7.4 7.5 8.1	**R-Tutorial**
9. June 27 - July 1	Continuous Uniform Distribution Exponential Distribution, Gamma Function, Memoryless Property	8.2 8.3	**Tutorial Quiz 4** **Note:** No classes will be held on Friday, July 1st (Canada Day) Happy 155th Birthday, Canada!
10. July 4 – 8	Computer Generation of Random Variables Normal (Gaussian) Distribution, Standard Normal Tables Chapter 8 Problems Basic Terminology and Techniques – Multivariate Distributions: Joint Probability Function, Marginal Probability Functions, Independent Random Variables, Conditional Probability Functions, Functions of Two or More Random Variables	8.4 8.5 8.6 9.1	**Open Tutorial - TBA** **Term Test 2** **Tuesday July 5th** **4:30 to 6:20 p.m.**
11. July 11 - 15	Multinomial Distribution: Joint Probability Function, Marginal and Conditional Probability Functions Expectations for Multivariate Distributions, Covariance and Correlation Coefficient and Their Interpretations	9.2 9.4	**Tutorial Quiz 5**
12. July 18 - 22	Mean and Variance of a Linear Combination of Random Variables Linear Combinations of Independent Normal Random Variables Indicator Random Variables Chapter 9 Problems	9.5 9.6 9.7 9.8	**Tutorial Quiz 6**
13. July 25, July 26	Central Limit Theorem and Approximations, Normal Approximation to Binomial and Poisson Distributions Moment Generating Functions Chapter 10 Problems	10.1 10.2 10.4	**Open Tutorial - TBA** **Note**: Monday July 25th follows a **MONDAY** schedule to make up for Victoria Day. Tuesday July 26th follows a **FRIDAY** schedule to make up for Canada Day. This is the **last** day of lectures