# STT 441-001: Probability and Statistics I: Probability

**Instructor**: Younggeun Kim (kimyo145@msu.edu)

**Grader**: Kaiwen Yang (yangkaiw@msu.edu)

**Room and Time:** MWF 3:00PM-3:50PM, Wells Hall A126

**Office Hours**: M/F 1:45PM-2:45PM, or by appointment, in Wells Hall C423 (except during holidays and fall break).

**Course Description**: This is the first course in a two-course sequence on introductory probability and statistical inference for students with a calculus background. STT 441 covers the probability theory and modeling portion of the sequence at an intermediate mathematical level. Topics include basic probability, conditional probability and independence; random variables—discrete and continuous; univariate and multivariate distributions; expectation and its properties; moment generating functions; the (weak) law of large numbers; and the central limit theorem. The course will cover Chapters 1–8 of the textbook.

**Textbook**:

- Ross, Sheldon M. *A First Course in Probability*, 10th edition, ISBN 9780134753119, Copyright 2018.

**Prerequisite**: MTH 234 or MTH 254H or LB 220 or approval of college.

# Course Details

**Homework Assignments**:

- There will be **eleven** homework assignments. The lowest score will be dropped.
- Homework is due at the beginning of class on Wednesdays and must be submitted in **hard copy**.
- **No** late homework will be accepted.
- Show all work and circle the final answer for numerical questions. Please staple your homework in the correct order (the order in which the problems were assigned) before submitting it.
- Make sure that your name appears on every page, and that the assignment number is written on the first page.

**Quizzes**:

- There will be **two** 50-minute quizzes during the semester. Quizzes cover a much smaller scope than exams.
- Quiz questions will be based on homework problems and examples given in class.
- Quiz problems are categorized into four levels of difficulty, with the following weights in the total quiz score:
    - Level 1: 20%
    - Level 2: 20%
    - Level 3: 20%
    - Level 4: 40%
- There will be **no** make-up quizzes.
- All quizzes are **closed notes** and will be taken **in person** on the following dates in the classroom:

Quiz 1: 09/24; Quiz 2: 11/12

- 3-minute bonus quizzes (1% each) may be given at the end of some classes. These credits will be added to your quiz scores, but the total quiz score is capped at 30%.

**Exams**:

- There will be **one non-comprehensive 50-minute midterm** and **one cumulative 120-minute final exam**.
- Exam problems are categorized into four levels of difficulty, with the following weights in the total exam score:
    - Level 1: 20%
    - Level 2: 20%

- Level 3: 20%
- Level 4: 40%

- There will be **no** make-up exams.
- All exams are **closed notes** and will be taken **in person** on the following dates in the classroom:

Midterm: 10/22; Final: 12/08.

**Course Evaluation:** eleven homework assignments (3% each; lowest score dropped, total 30%), two quizzes (10% each, plus extra credit from bonus quizzes, totaling up to 30%), one midterm exam (20%), and one final exam (30%).

The current plan is to categorize textbook examples, theoretical proofs, and homework problems into Levels 1–4, post the lists one week before Quiz 1, Quiz 2, the Midterm, and the Final. This plan is tentative and subject to change. Quizzes and exams may include extra-credit problems on advanced topics. The grades will be given roughly according to the following scheme:

| Grade | Range |
|---|---|
| 4.0 | 90% and above |
| 3.5 | 80% - 89.99% |
| 3.0 | 70% - 79.99% |
| 2.5 | 65% - 69.99% |
| 2.0 | 60% - 64.99% |
| 1.5 | 55% - 59.99% |
| 1.0 | 50% - 54.99% |
| 0 | 0% - 49.99% |

**Summary of Score Components and Example Scenarios:**

| Component | Individual Weight | Total Weight |
|---|---|---|
| 11 Homework Assignments | 3% each | 30% (lowest score dropped) |
| 2 Quizzes | 10% each | 20% |
| Midterm Exam | 20% | 20% |
| Final Exam | 30% | 30% |
| **Total** | - | **100%** |
| 3-minute Bonus Quizzes | 1% each | TBD (added to quiz scores, but the total quiz score is capped at 30%) |
| Extra-Credit Problems on 2 Quizzes, the Midterm, and the Final | TBD | TBD |

The following are example cases for earning grades of 3.0, 3.5, and 4.0, respectively. If you lose points on homework assignments or miss many bonus quizzes, you will need to make up for them by earning higher scores on the more difficult problems in Quiz 1, Quiz 2, the Midterm, and the Final in order to achieve comparable final grades.

*1) Example Case for a Grade of **3.0**:* When a student receives full credit for homework assignments, full credit on **all Level 1 problems** in the two quizzes, the midterm, and the final exam, and earns full extra credit from bonus quizzes (but no credit from any other components), the breakdown is as follows:

| **Component** | **Total Earned Score** |
|---|---|
| 11 Homework Assignments | 30% (lowest score dropped) |
| 2 Quizzes | 4% (= 20% x 0.2) |
| Midterm Exam | 4% (= 20% x 0.2) |
| Final Exam | 6% (= 30% x 0.2) |
| **Total** | **44%** |
| 3-minute Bonus Quizzes | 26% (in addition to the 4% earned from Quizzes 1 and 2; the total quiz score is capped at 30%) |
| Extra-Credit Problems on 2 Quizzes, the Midterm, and the Final | 0% |
| **Final Score including Extra-Credit** | **70% (= 44% + 26%)** |

*2) Example Case for a Grade of **3.5**:* When a student receives full credit for homework assignments, full credit on **all Level 1 and 2 problems** in the two quizzes, the midterm, and the final exam, and earns full extra credit from bonus quizzes (but no credit from any other components), the breakdown is as follows:

| **Component** | **Total Earned Score** |
|---|---|
| 11 Homework Assignments | 30% (lowest score dropped) |
| 2 Quizzes | 8% (= 20% x 0.4) |
| Midterm Exam | 8% (= 20% x 0.4) |
| Final Exam | 12% (= 30% x 0.4) |
| **Total** | **58%** |
| 3-minute Bonus Quizzes | 22% (in addition to the 8% earned from Quizzes 1 and 2; the total quiz score is capped at 30%) |
| Extra-Credit Problems on 2 Quizzes, the Midterm, and the Final | 0% |
| **Final Score including Extra-Credit** | **80% (= 58% + 22%)** |

*3) Example Case for a Grade of **4.0**:* When a student receives full credit for homework assignments, full credit on **all Level 1, 2, and 3 problems** in the two quizzes, the midterm, and the final exam, and earns full extra credit from bonus quizzes (but no credit from any other components), the breakdown is as follows:

| **Component** | **Total Earned Score** |
|---|---|
| 11 Homework Assignments | 30% (lowest score dropped) |
| 2 Quizzes | 12% (= 20% x 0.6) |
| Midterm Exam | 12% (= 20% x 0.6) |
| Final Exam | 18% (= 30% x 0.6) |
| **Total** | **72%** |
| 3-minute Bonus Quizzes | 18% (in addition to the 12% earned from Quizzes 1 and 2; the total quiz score is capped at 30%) |
| Extra-Credit Problems on 2 Quizzes, the Midterm, and the Final | 0% |
| **Final Score including Extra-Credit** | **90% (= 72% + 18%)** |

**Academic Honesty:** The Department of Statistics and Probability adheres to the policies of academic honesty as specified in the General Student Regulations 1.0, Protection of Scholarships and Grades and in the All-University Policy on Integrity of Scholarship and Grades which are included in Spartan Life: Student Handbook and Resource Guide. Students who plagiarize will receive a grade 0.0 on the assignment or exam.

**Accommodation for Students with Disabilities:** Students with disabilities should contact the Resource Center for People with Disabilities at 517-884-RCPD or on the web at rcpd.msu.edu. If you are eligible for an accommodation, you will be issued a verified individual service accommodation (VISA) form. Please present this form to me at the start of the term or two weeks prior to the accommodation date.

**Diversity Statement:** I am committed to fostering a learning environment that respects and embraces diversity in all its forms. Our classroom is a space where everyone, regardless of race, ethnicity, gender, sexual orientation, religion, age, disability, socioeconomic status, or background, is valued and heard. I consider it part of my responsibility as an instructor to address the learning needs of all students in this course. It is also the responsibility of all students to exhibit professional courtesy and respect for all members of the class. The course materials and discussions are intended to be respectful of social identities. Any suggestions that you have about other ways to incorporate diverse experiences in the course materials or discussions are welcome. Together, we can create a classroom environment that not only values diversity but also actively leverages it to enhance our collective learning experience.

**Statistics Learning Center:**

- The Statistics Learning Center (SLC) will be delivered through in-person only in Wells Hall D101.
- **What can students expect from the tutors at SLC?** - SLC service exists and is designed to *supplement* a student's learning and comprehension of classroom material. It is not a substitute for attending lectures and recitation meetings. SLC tutors will not check the homework answers or solve the homework problems for students.

  Students should go to SLC with specific questions after having done their best to find the answers in the course lectures and other learning materials. Students should be aware that the SLC tends to be crowded in the hours just before assignments are due and before exams. Students should go early to get more attention and to have more time to ask questions.
- Check further details at https://stt.natsci.msu.edu/academics/statistics-learning-center-1.aspx

**Disclaimer:** The instructor reserves the right to make any changes considered academically advisable. Changes will be announced in class. It is your responsibility to keep up with any changed policies.

**Weekly Schedule:** Details can change.

| Week | Date | Topic | Remark |
|---|---|---|---|
| 1 | 08/25 (M) | Orientation (Course logistics)<br>1.1. Introduction<br>1.2. The Basic Principle of Counting | |
| | 08/27 (W) | 1.3. Permutations<br>1.4. Combinations (Part 1) | HW01 released |
| | 08/29 (F) | 1.4. Combinations (Part 2)<br>1.5. Multinomial Coefficients | |
| 2 | **09/01 (M)** | **Holiday – University Closed** | |
| | 09/03 (W) | 2.1. Introduction<br>2.2. Sample Space and Events | HW01 due (beginning of class); HW02 released |
| | 09/05 (F) | 2.3. Axioms of Probability | |
| 3 | 09/08 (M) | 2.4. Some Simple Propositions | |
| | 09/10 (W) | 2.5. Sample Spaces Having Equally Likely Outcomes<br>2.7. Probability as a Measure of Belief | HW02 due (beginning of class); HW03 released |
| | 09/12 (F) | 3.1. Introduction<br>3.2. Conditional Probabilities (Part 1) | |
| 4 | 09/15 (M) | 3.2. Conditional Probabilities (Part 2) | |
| | 09/17 (W) | 3.3. Bayes's Formula (Part 1) | HW03 due (beginning of class) |
| | 09/19 (F) | 3.3. Bayes's Formula (Part 2)<br>3.4. Independent Events (Part 1) | |

| | | | |
|---|---|---|---|
| 5 | 09/22 (M) | 3.4. Independent Events (Part 2)<br>3.5. P(·\|F ) Is a Probability | |
| | 09/24 (W) | **Quiz 1 (50 mins)** | **Quiz 1**: 1.1. ~ 2.7.<br>HW04 released |
| | 09/26 (F) | 4.1. Random Variables<br>4.2. Discrete Random Variables | |
| 6 | 09/29 (M) | 4.3. Expected Value<br>4.4. Expectation of a Function of a Random Variable (Part 1) | |
| | 10/01 (W) | 4.4. Expectation of a Function of a Random Variable (Part 2)<br>4.5. Variance | HW04 due (beginning of class); HW05 released |
| | 10/03 (F) | 4.6. The Bernoulli and Binomial Random Variables | |
| 7 | 10/06 (M) | 4.7. The Poisson Random Variable (Part 1) | |
| | 10/08 (W) | 4.7. The Poisson Random Variable (Part 2) | HW05 due (beginning of class); HW06 released |
| | 10/10 (F) | 4.8. Other Discrete Probability Distributions | |
| 8 | 10/13 (M) | 4.9. Expected Value of Sums of Random Variables<br>4.10. Properties of the Cumulative Distribution function | |
| | 10/15 (W) | 5.1. Introduction | HW06 due (beginning of class) |
| | 10/17 (F) | 5.2. Expectation and Variance of Continuous Random Variables | |
| 9 | **10/20 (M)** | **Fall Break** | |
| | 10/22 (W) | **Midterm Exam (50 mins)** | **Midterm Exam:** 3.1.~ 4.10.<br>HW07 released |
| | 10/24 (F) | 5.3. The Uniform Random Variables<br>5.4. Normal Random Variables (Part 1) | |
| 10 | 10/27 (M) | 5.4. Normal Random Variables (Part 2) | |
| | 10/29 (W) | 5.5. Exponential Random Variables<br>5.6. Other Continuous Distributions (Part 1) | HW07 due (beginning of class); HW08 released |
| | 10/31 (F) | 5.6. Other Continuous Distributions (Part 2)<br>6.1. Joint Distribution Functions (Part 1) | |
| 11 | 11/03 (M) | 6.1. Joint Distribution Functions (Part 2)<br>6.2. Independent Random Variables | |
| | 11/05 (W) | 6.3. Sums of Independent Random Variables<br>6.4. Conditional Distributions: Discrete Case | HW08 due (beginning of class) |
| | 11/07 (F) | 6.5. Conditional Distributions: Continuous Case<br>6.6. Order Statistics | |
| 12 | 11/10 (M) | 7.1. Introduction | |

| | | | |
|---|---|---|---|
| | | 7.2. Expectation of Sums of Random Variables (Part 1) | |
| | 11/12 (W) | **Quiz 2 (50 mins)** | **Quiz 2**: 5.1. ~ 5.6.<br>HW09 released |
| | 11/14 (F) | 7.2. Expectation of Sums of Random Variables (Part 2)<br>7.4. Covariance, Variance of Sums, and Correlations (Part 1) | |
| 13 | 11/17 (M) | 7.4. Covariance, Variance of Sums, and Correlations (Part 2) | |
| | 11/19 (W) | 7.5. Conditional Expectation (Part 1) | HW09 due (beginning of class); HW10 released |
| | 11/21 (F) | 7.5. Conditional Expectation (Part 2) | |
| 14 | 11/24 (M) | 7.7. Moment Generating Functions | |
| | 11/26 (W) | 8.1. Introduction<br>8.2. Chebyshev's Inequality and the Weak Law of Large Numbers (Part 1) | HW10 due (beginning of class); HW11 released |
| | **11/28 (F)** | **Holiday – University Closed** | |
| 15 | 12/01 (M) | 8.2. Chebyshev's Inequality and the Weak Law of Large Numbers (Part 2) | |
| | 12/03 (W) | 8.3. The Central Limit Theorem (Part 1) | HW11 due (beginning of class) |
| | 12/05 (F) | 8.3. The Central Limit Theorem (Part 2) | |
| 16 | 12/08 (M) | **Final Exam (120 mins)**:<br>3:00PM – 5:00PM (Wells Hall A126) | **Final Exam**: All course content |