



GOSHEN COLLEGE
MATHEMATICS DEPARTMENT
MATH 323 PROBABILITY & STATISTICS – SPRING 2023-24

Catalog Description	(3 credits) An introduction to the theory, practice and computer simulation of probability and statistics. Data exploration, sample spaces, random variables, probability distributions and their derivations, probability simulations and statistical inference. Prerequisite: Math 211 and either Math 205 or 212.
Content	Observations, experiments, and simulations generate data. This course studies techniques for summarizing data with graphs and numbers and how data can be used to infer something about the phenomena from which the data were generated. These techniques depend upon an understanding of the probability of events arising from idealized populations. There will be a balance between how to use the techniques and the theoretical underpinnings of the techniques.
Learning Objectives	<p>The student will be able to do the following:</p> <ol style="list-style-type: none">1. Identify and distinguish between population and sample, parameter and statistic, theoretical and empirical, quantitative and qualitative, variable and data, experiment and observation, random and convenience sample, random variable and sample space.2. Estimate, compute, and interpret descriptive statistics (e.g., mean, median, standard deviation, percentiles, correlation, best-fit linear model parameters).3. Construct and interpret graphical summaries of data (e.g., histogram, box plot, scatter plot, quantile-quantile plot).4. Use software for statistical computation and simulation.5. Describe and identify theoretical, empirical, and subjective forms of probability.6. Define and identify independent events and random variables.7. Compute unconditional and conditional probabilities using systematic enumeration, addition and multiplication rules, complements, permutations, combinations, Bayes' Theorem, and simulation.8. Use probability distributions (e.g., uniform, binomial and Poisson) and densities (e.g., uniform, normal, and gamma) to compute probabilities and expected values.9. Compute (via normal and simulation approximation) and interpret confidence intervals for simple parameters (e.g., mean and standard deviation).10. Compute and interpret simple hypotheses tests (e.g., mean, difference in means, and model fit).11. Derive formulas for use in linear best fit, probability distributions, random variable distributions, parametric confidence intervals, test statistic distributions.12. Learn mathematics by reading, listening, exploring, and conversing in an effective manner.13. Explain mathematical reasoning through writing in a precise and articulate manner in

both informal and formal settings.

14. Exhibit curiosity, playfulness, creativity, confidence, perseverance, interest in multiple perspectives, and a collaborative spirit.

Activities	<p>The study of mathematics is not a spectator sport! Reading, listening, solving problems, writing explanations, reflecting upon ideas, and receiving feedback are essential to learning mathematics. Read with paper and pencil in hand, and take an anticipatory approach: try to obtain solutions, explanations, and proofs before reading what the author provides. Write down specific questions when you do not understand a portion of the text or a lecture. Try to recreate the key ideas, solve problems, and write proofs without looking at the book or notes.</p> <p>An average student can obtain an average grade with an average of nine hours each week devoted to this course—adjust if you are not average or desire a grade that is not average.</p>
Instructor	<p>David Housman, SC 117, dhousman@goshen.edu, 535-7405. See office door or Moodle for availability.</p>
Class Time	<p>MWF 1:00 – 1:50pm in SC 107.</p>
Textbooks	<p>There is no required text for this course; however, many texts will be referenced:</p> <p>Johannes Ledolter and Robert V. Hogg, <i>Applied Statistics for Engineers and Physical Scientists</i>, 3rd edition, Pearson Education, 2010, ISBN: 978-0-13-601798-1. A copy of this book and the student solutions manual will be available on the Good Library reserve shelf.</p> <p>Garrett Grolemond and Hadley Wickham, <i>R for Data Science</i>, 2nd edition, https://r4ds.hadley.nz/.</p> <p>Chi Yau, <i>R Tutorial: An R Introduction to Statistics</i>, https://www.r-tutor.com/r-introduction.</p> <p>Joseph K. Blitzstein and Jessica Hwang, <i>Introduction to Probability</i>, 2nd ed, A free pdf version can be obtained from the Statistics 110: Probability web page https://projects.iq.harvard.edu/stat110/home.</p> <p>Chester Ismay and Albert Y. Kim, <i>ModernDive: An Introduction to Statistical and Data Sciences via R</i>, https://moderndive.com/.</p>
On-line	<p>Moodle https://moodle.goshen.edu contains all course information. Announcements posted to the forum will be emailed to all students.</p>
Software	<p>The statistical programming language <i>R</i> and the integrated development environment <i>RStudio</i> will be used. Both are freely available open-source software and are installed on campus lab computers. Sage (sagemath.org) and its collaborative notebook interface CoCalc (cocalc.com) may also be used for symbolic computation.</p>
Notebook	<p>A three-ring binder with loose-leaf lined and graph paper is recommended so that you can keep a written record of problem-solving attempts, questions, math discoveries, and skill assessments.</p>

Grading

Grades will depend upon your performance on assignments (60%), one midterm exam (20%), and a final exam (20%). If beneficial, your final exam grade will replace your grade on the midterm exam. The course grade will be translated into letter grades in the following manner.

Minimum Percentage	93	90	87	83	80	77	73	70	67	60	0
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	F

In order to receive a passing grade in this course, the average of your exam scores or your final exam score must be 60% or higher—regardless of your non-exam scores. A semester average of at least 90%, 80%, 70%, and 60% will earn a grade of A-, B-, C-, and D, respectively. Some upward adjustment may be made based upon class participation and individual effort and progress.

Assignments

Achieve and demonstrate understanding by completing the assigned exercises. Your solutions will be evaluated on the correctness of your mathematical descriptions and arguments, the clarity of your writing, and the quality of your presentation.

Assignments are typically due at the *start* of or *before* the class after the class during which the corresponding topic was discussed. Individual exercise solutions can be resubmitted or submitted late by the class period after the first submissions are graded and returned to students, but a 30% penalty will be assessed on these resubmissions and late submissions. When resubmitting work, include the originally graded work.

You are encouraged to collaborate and seek assistance when having difficulties. You will have achieved the expected level of understanding when you are able to obtain your own solutions, independently reproduce solutions developed in collaboration or with assistance, and/or explain a solution to others.

Extra Credit

Receive extra credit toward your assignments grade by doing one or more of the following: (1) find errors in the texts or posted course materials and describe the error; (2) attend a quantitative presentation (e.g., [Science Speakers](#)) or participate in a quantitatively based activity and describe in writing some interesting mathematical aspect of the presentation or activity; or (3) participate in a [Career Networks](#) event and describe your most important discovery. Turn in to the instructor a single piece of paper containing your description.

Exams

Exhibit your mastery of the learning objectives without assistance or collaboration. There may be both in-class and take-home portions for each exam.

Tutoring

The Academic Success Center provides limited tutoring and writing support for free to all undergraduate students. Make an appointment at goshen.edu/asc. However, it is unlikely that the ASC can hire someone with adequate knowledge of this course. Your best option is to ask the instructor!

**Accessibility
Accommodations** Goshen College is committed to providing all students equitable access to programs and facilities. Students who need accommodations based on disability should contact the Academic Success Center (ASC). Students must register with the ASC before faculty are required to provide reasonable accommodations. For more information or to register, please contact the Director of Academic Success, Michelle Blank, Good Library 112, mblank@goshen.edu or 574-535-7526. To ensure that learning needs are met, contact the ASC the first week of classes. More information at: <https://www.goshen.edu/campuslife/asc/disability-services/>.

**Collaboration
and
Academic
Integrity** You are encouraged to use all available resources in order to learn the concepts and techniques discussed in this course. In particular, conversations with other students and the instructor can be an effective learning method. Reading other books and web pages can be another effective learning method. However, copying someone else's work subverts the learning process.

For assignments, you may look at and discuss another student's work, but any written work developed during collaboration with another student should be destroyed before writing your own solutions. You should give written acknowledgement to people with whom you have had discussions and to any written materials (other than the text) that were helpful.

For exams, you may *not* use any resources unless a specific exception is stated by the instructor.

Failure to observe the above rules will result in a zero on the assignment or exam. Any violation of academic integrity will be reported to the Academic Dean. Observation of the above rules will help you learn the material well and give you the satisfaction of knowing that you have earned your grade.

Due Date Policy Class participation, assignments, labs, and exams can only be excused, rescheduled, or made up if (1) there is a serious medical problem, a death in the immediate family, or an irreconcilable conflict with another official Goshen College activity; (2) there is written documentation signed by proper authorities; and (3) the instructor is notified prior to the due date or as soon as possible afterwards.

**Course
Materials are for
Private Use** Course materials (videos, assignments, exams, problem sets, etc) are for use in this course only. You may not upload them to external sites, share with any person outside this course, or post for public commentary without written permission from the professor. Sharing recordings outside of the class could lead to a copyright or FERPA violation. Goshen College prohibits any student from duplicating, downloading, or distributing class recordings with anyone outside of this class, for any reason.