Math 450: Mathematical Statistics

Spring 2024: Section 1

	Instructor Information		Course Information
Name:	Dr. Christina Durón	**Time**:	MTRF 12:00PM – 12:50PM
Email:	christina.duron@pepperdine.edu		
Office:	RAC 105	**Location**:	RAC 170
Office Phone:	(310) 506 – 4832	**Module**:	In-person

Course Pages:

1. Courses (Required): `https://courses.pepperdine.edu`
2. Gradescope (Required): `https://www.gradescope.com`
3. Homepage (Optional): `https://cduron.info`

Office Hours: Office Hours will be held regularly in RAC 105 on

- Mondays and Fridays: 1:00PM – 2:00PM
- Tuesdays and Thursdays: 10:00AM – 11:00AM
- By appointment

In addition, questions may be addressed through email between 8AM – 5PM (PST) during the academic week (i.e., Monday through Friday). Please allow up to 24 hours for a response, although the instructor will strive to reply promptly. Emails received over the weekend will receive a reply on the first University academic day (excluding any national, state, or University holiday) following the weekend.

Course Materials:

- *Textbook*: The course textbook (electronic or hardcover) is *Mathematical Statistics*, 7th Edition by Wackerly, Mendenhall, and Scheaffer. While the textbook is not required, it is a highly encouraged resource. Should you purchase/rent the textbook, it is important that you *read the sections in addition to attending lectures and doing assigned work.*
- *Calculator*: A graphing calculator is a tool that will be used in this course. Any model in the TI-83 or TI-84 series is recommended. Models that can perform symbolic calculations (also known as CAS) are not allowed on exams and quizzes. CAS models include (but are not limited to) the TI-89, TI NSpire CAS and HP 50g. Students are not allowed to share calculators during quizzes and exams.
- *Software*: For this course, you will need daily access to a device with a reliable internet signal that can:
  - Access Courses.
  - Access Gradescope.
  - Scan and upload written work to Gradescope.
  - View and download PDF documents.
- *Technology*: Throughout the course we will use both `R` through the interface `RStudio`. The instructions for downloading this free software are below. **Note**: To use `RStudio` make sure to open the `RStudio` program (and not the `R` program).
  - **Mac Instructions**:
    1. Go to `https://cran.r-project.org/bin/macosx/` and download the R-4.1.2.pkg file and double click to install.

2. Go to https://www.rstudio.com/products/rstudio/download/#download and download RStudio-2021.09.1-372.dmg - Mac OS X 10.14+ (64-bit).
3. Double click on the dmg file and then drag RStudio.app to the Applications folder to install.

– **Windows Instructions**:

1. Go to https://cran.r-project.org/bin/windows/base/ and download R 4.1.2 for Windows. Double click to install.
2. Go to https://www.rstudio.com/products/rstudio/download/#download and download RStudio-2021.09.1-372.exe - Windows 10 (64bit).
3. Double click to install.

Course Communications: All course materials will be posted on Courses. Email, in-class announcements, and Courses announcements will be the primary methods to communicate course information. It is ultimately the student's responsibility to keep informed of any announcements, syllabus adjustments, or policy changes made during scheduled classes, by email, or through Courses.

Course Prerequisites: The enrollment requirement includes a C− or better in Math 350.

Course Description: Math 450 provides an introduction to the basic mathematical properties of statistical methods for data analyses including parametric estimation, hypothesis testing, linear least square estimation, analysis of variance and analysis of categorical data. Additional topics include include sampling, standard error, methods or finding estimates (such as method of moments and maximum likelihood) and analyzing their accuracy through analysis bias, standard errors and confidence intervals, use of normal, t, chi-square, and F distributions, large sampling methods, correlation, along with common errors and problems in statistical reasoning and experimental design.

Course Objectives:

1. Demonstrate knowledge of, and properties of, statistical models in common use.
2. Understand the basic principles underlying statistical inference (estimation and hypothesis testing).
3. Be able to construct tests and estimators, and derive their properties.
4. Demonstrate knowledge of applicable large sample theory of estimators and tests.

Student Learning Outcomes: Upon completing this course, students should be able to:

1. Analyze data to capture common statistics, and to explain their use.
2. Calculate parameter estimates and indicate their reliability
3. Understand and be able to determine confidence intervals and know how sample size affects these intervals.
4. Understand how hypothesis testing relates to probability distributions and be able to perform and analyze results from the relevant tests (t-test, χ^2-test, etc.)
5. Understand the principles behind analysis of variance (ANOVA) and be able to use and analyze the test.
6. Understand the principles behind regression, and be able to use and interpret correlation and regression information.
7. Use and interpret some of the basic nonparametric statistical methods.

Relation to Mathematics Program Learning Outcomes: A student who completes a mathematics degree should be able to use appropriate mathematical ideas in applied or real-world contexts.

Relation to Pepperdine's Mission: Pepperdine is a Christian university committed to the highest standards of academic excellence and Christian values, where students are strengthened for lives of purpose, service, and leadership. This course is designed to complement and supplement the overall mission of Pepperdine. Mathematics courses have historically been used to "train the mind" of students, to help students think more carefully and clearly. In logical preparation and in application of concepts, the study of mathematics helps prepare you for a life of purpose, service, and leadership.

Attendance and Class Participation Policy: Participating in the course and attending lectures and other course events are vital to the learning process. As a result, students are expected to attend each class meeting and to arrive on time and ready to participate in discussion or group work with their peers. Students are responsible for the material covered if they are late or absent. If you are unexpectedly absent for medical or personal reasons, please inform the instructor within 24 hours, if at all possible, and provide a note from the appropriate party (e.g., doctor, Divisional Dean) excusing the absence.

Classroom Behavior Policy: To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a website, making phone calls). Students are asked to refrain from disruptive conversations during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion, and may be reported to the Divisional Dean.

Gradescope: Students are expected to create an account with Gradescope, linked to your `@pepperdine.edu` address. If you already have a Gradescope account linked to your `@pepperdine.edu` address, then you do not need to create another account. Students are expected to read the guide for submitting work to Gradescope. To upload your work, log into your Gradescope account, find the course Gradescope page, select the correct assignment, and upload your scanned work as a PDF file. If you cannot find the course Gradescope page, then you may need a course entry code (provided on Courses under Resources).

Assignments and Examinations:

- **Homework** will be distributed electronically (both on Gradescope and Courses), based in part on the text. Students are responsible for uploading properly scanned work (as a single PDF file) to Gradescope by 11:59PM on the indicated due date, and assigning the appropriate pages for each problem. The instructor will grade either a subset or all of the problems each week; graded work will be returned through Gradescope. Students must show all work in a legible, neat and organized manner to receive credit. No credit will be given if the solution is not justified, if the work is illegible, or if the submitted file is corrupted (e.g., cannot be viewed on Gradescope).

  You are strongly encouraged to work with other students in doing the homework, but the homework turned in must be your own and represent your own thinking and your own work. Turning in the work of others (including that provided by generative AI tools), allowing others to copy your work, or copying from a solutions manual or other source is a violation of Seaver College' Code of Ethics (see your student handbook for more information). This can lead to a lowering of your course grade as well as counting as one of two ethics violations allowed at Seaver College. On each assignment, you will be asked to provide your collaborators.

  Please be aware that checking unsanctioned online sources for solutions is not allowed and may be reported as cheating. In addition, the use of generative AI tools is strictly prohibited; the use of such source will result in an automatic zero on the assignment/assessment and will be reported as cheating.

  Note: I reserve the right to give periodic in-class quizzes based on the homework, possibly without notice.

- **Semester Project**: The class will be divided into groups of two to three for final projects. The class will be provided with the same large data set from which there are many possible statistical questions. Each part of the project will ask your group to examine a subset of the larger data set using statistical techniques developed in class. All statistical calculations should be performed in `R`. Whenever appropriate, your analysis should include a plot.

  - **Part 1**: Plot (Due 1/26, 10 points)
    Make a hypothesis using a subset of the data and construct a plot that provides evidence for that hypothesis. Include a paragraph that clearly states what segment of the data you chose to plot, why you chose to plot that segment of the data and why you chose to use the particular type of plot (scatter plot, dot plot, box plot, bar graph, pie chart, etc). Clearly define the variables in the plot and use appropriate labels. You do not need to perform any formal statistical analysis. Your write-up should not exceed one page including the plot.

  - **Part 2**: Confidence Intervals (Due 2/16, 20 points)
    Construct a confidence interval for a mean (or difference in means) AND for a population proportion (or difference in population proportions). For each interval, state the parameter(s) of interest, the standard error, and the confidence interval. Explain why you chose to use a Normal or t-distribution to construct the interval. Explain why you chose to find confidence intervals for those parameters and interpret the confidence intervals in context. Your write-up should not exceed one page.

  - **Part 3**: Hypothesis Tests (Due 3/22, 24 points)
    State two hypotheses, one for a mean (or difference in means) AND one for a population proportion (or difference in population proportions). The hypotheses can relate to the plot in Part 1 or the confidence intervals from Part 2 or they can be entirely new hypotheses. Describe the data used to address these hypotheses. Explain why a test based on the Normal or t-distribution is appropriate for this data. For each test, state the parameter(s) of interest, the significance level, the standard error, the test statistic, the confidence interval, and the p-value. State the precise statistical conclusion and give an interpretation in context. Be careful not to overstate your conclusions. Your write-up should not exceed one page for each hypothesis including relevant plots.

  - **Part 4**: Linear Regression (Due 4/5, 15 points)
    Find a linear regression for two variables within the provided data set. Explain why a linear model is appropriate for these data. State the equation for the regression, the correlation coefficient, and the residual standard deviation. Interpret the slope of the linear regression and the coefficient of determination in context. Perform a hypothesis test for either the correlation coefficient or the slope. Your write-up should not exceed one page including a plot of the data with the regression line, confidence interval and prediction interval.

  - **Part 5**: χ^2 or ANOVA (Due 4/19, 15 points)
    State a hypothesis and perform the appropriate χ^2 test or ANOVA. Describe the data used to address these hypotheses. Explain why the test you chose is appropriate including any conditions that must be satisfied. State the significance level, the test statistic, the p-value and any other relevant calculations. State the precise statistical conclusion and give an interpretation in context. If necessary, perform the appropriate post-hoc test and interpret the results. Be careful not to overstate your conclusions. Your write-up should not exceed one page.

  - **Final Presentation**: Tuesday, April 23, 2024, at 10:30AM – 1:00PM (16 points)
    Each group will give an oral presentation summarizing their findings during the final exam period. A rubric for each of the parts of the project as well as the final presentation will be provided.

- **Midterms** will be taken during the class period. Please refer to the calendar for the dates of these four exams. Each exam will be written to be completed within 45 minutes. See the cover page on each exam for specific instructions about the use of notes and technology.

- **Participation** is a vital component of class success. Students are expected to keep up with class, engage and participate both in large class discussions and group work, and in general contribute to a sense of classroom community. The participation grade is meant to encourage and reward class-wide (rather than individual) efforts to create a sense of classroom community so that this course can be effective, regardless of course modality. If each of you do all you can every day to participate as you are able, this can be a great course with everyone receiving 100% for participation. However, if you personally stop regularly attending and participating in class (without excused reasons) or if too few students participate for the course to run smoothly and effectively, the instructor reserves the right to implement individual or group participation requirements.

Important Dates:

Last day of Add/Drop period	January 12, 2024
Withdraw period begins	January 13, 2024
Last day to change Cr/NC status	January 22, 2024
Midterm #1	**February 2, 2024** (*tentative*)
Midterm #2	**February 23, 2024** (*tentative*)
Last day to withdraw (with W)	March 11, 2024
Midterm #3	**March 15, 2024** (*tentative*)
Midterm #4	**April 12, 2024** (*tentative*)
Last day to withdraw (with WP/WF)	April 12, 2024 (by 5PM)
Last day to submit Change of Final Exam form	April 12, 2024
Final Presentation	**April 23, 2024**

Make-Up Exams and Homework Extensions: In general, there will be no make-up exams. However, in unusual circumstances beyond your control, a make-up exam may be given on a case-by-case basis. This may require providing a detailed account of the situation and, if applicable, supporting documents. Approval in these cases is at the sole discretion of the instructor and/or the Divisional Dean.

Homework assignments not turned in by the due date will receive an automatic zero. Extensions may be granted on a case by case basis (a valid reason must be given); all requests must be made at least 48 hours in advance of the due date(s); requests made within 48 hours of the due date(s) will not be granted.

Dispute of Grade Policy: Any questions regarding the grading of any assignment, quiz or exam need to be cleared up within one week after the graded item has been returned.

Grading Scale and Policies: Your work in this course will be weighted as follows:

- Participation (2%)
- Homework & Quizzes (10%)
- Midterm Exams (72%; 18% each)
- Final Presentation (16%)

The weighted percentages below correspond to your final letter grade:

A: 93 – 100%	B+: 87 – 89%	C+: 77 – 79%	D+: 67 – 69%	F: 0 – 59%
A−: 90 – 92%	B: 83 – 86%	C: 73 – 76%	D: 63 – 66%	
	B−: 80 – 82%	C−: 70 – 72%	D−: 60 – 62%	

Note: No extra credit or bonus points are offered in this course.

Assistance: I will be available in my office for questions during the posted Office Hours or whenever the door is open. If you need to reach me outside of those hours, please email me to make an appointment. There will be peer tutoring available in the Student Success Center most evenings. See https://seaver.pepperdine.edu/academics/academic-support/student-success-center/departmental-tutoring.htm for details.

Class Expectations: It is my goal to teach you all the material necessary to be successful in this course. In return, I expect that you will show up to class on time and ready to work. We will use calculators for mathematical applications, but I expect that you will refrain from the use of cell phones, tablets or laptops unless instructed otherwise.

In order to make the class more interesting, I will alternate between lectures and group activities. We can only cover all of the material successfully in this way if you make an effort to stay on task. Working in groups is an excellent opportunity to learn from each other. You will know that you have mastered a subject when you can successfully teach that topic to a fellow student.

It is my expectation that you will spend at least two hours outside of class for every hour you spend in class studying and working on homework. If you put in eight hours a week, then you should be able to complete your assignments and study for your exams. If you do this for each class, then a 16 – 18 unit load will give you a 48 – 54 hour work week, which is not unreasonable in many professions.

As students at Pepperdine University, you are expected to approach this class with a Christian attitude. You should be willing to help your fellow classmates understand the material while working in groups or outside of class. Our classroom is a place to ask questions without feeling ashamed or looking foolish. Since your peers are entering this course with a broad spectrum of mathematical backgrounds, you should be patient with others asking questions and encourage one another in love.

As a professor at Pepperdine University, I will approach this class with a Christian attitude, viewing my role as that of a servant, being concerned first for your personal, especially intellectual, development. One of my goals is to build a community that is understanding and encourages one another. I commit to reporting grades that accurately and honestly reflect the level of work done in the class, as described in the paragraphs above.

Student Accessibility: Pepperdine University provides services and accommodations in accordance with the ADA and section 504 of the Rehabilitation Act. Pepperdine recognizes that each student is a unique individual and that the effect of a particular disability can vary from student to student. As a result, accommodations are determined through an interactive process with the student, the Office of Student Accessibility, and medical/mental health professionals.

Any student with a documented disability (chronic medical, physical, learning, psychological, or temporary) needing academic accommodations should contact the Office of Student Accessibility (Student Assistance Center, SAC #105, Phone: (310) 506 – 6500, Email: student.accessibility@pepperdine.edu) as early in the semester as possible. All discussions will remain confidential. For additional information, please visit `http://www.pepperdine.edu/student-accessibility/`.

Ethics: Academic Integrity is the expression of intellectual virtue in human beings as a result of their creation in God's image. It represents the convergence of the best of the human spirit and God's spirit, which requires personal, private and community virtue. As a Christian institution, Pepperdine University arms that integrity begins in our very created being and is lived out in our academic work. In order for the code to be effective, the community must maintain its health and vitality. This requires a genuine sense of maturity, responsibility, and sensitivity on the part of every member. Each member of the Seaver College community is expected to pursue their academic work with honesty and integrity.

Academic integrity is violated when one of the following events occurs:

- Plagiarism
- Cheating
- Fabrication, or
- Facilitating Academic Dishonesty

For a more detailed description of these violations, see `http://seaver.pepperdine.edu/academicintegrity/policies/violations.htm`. All violations will be reported and handled according to the Academic Integrity Committee Procedures. In particular, any instance of cheating or plagiarism on an assignment or exam will be reported and result in no credit. As a reminder, the use of generative AI, AI writing, or similar AI tools

or services is not permitted in any aspect of this class; the use of such tools will be considered a violation of academic integrity and be reported accordingly.

Course Evaluations: Online course evaluations are conducted for all Seaver College courses and are part of Pepperdine University's commitment to excellence in teaching and learning. The evaluations provide useful feedback that faculty and schools use to improve the quality of instruction. Each instructor receives a compilation of the anonymous responses and comments to use in evaluating their own teaching and planning future courses. Faculty do not have access to course evaluation data until all course grades are posted. The course evaluation period opens at 7AM on Monday, April 8 and closes before final exams begin (3AM on Monday, April 22). To access the online course evaluation system, you may log on directly at https://courseeval.pepperdine.edu/.

Consent to be Recorded: Class sessions may be recorded by the professor using the Zoom recording feature for instructional purposes. Participation in the class during live sessions implies consent to the recording of those sessions. If a student does not wish to be recorded, they must notify the instructor to see if arrangements can be made. If this is not possible for educational reasons, the student may need to enroll in a different course.

Student and Faculty Privacy: In order to safeguard the privacy of all our students and faculty in online learning environments, no individual may record, reproduce, screenshot, photograph or distribute any video, audio, or visual content from an online course. This restriction applies to, but is not limited to, live sessions, recorded lectures, live discussions, and discussion boards. The only exceptions to this policy are the instructional recordings referenced above. Any violation of this policy may subject the individual to disciplinary and/or legal action.

Intellectual Property: Course materials prepared by the instructor, together with the content of all lectures and review sessions presented by the instructor, are the property of the instructor. Video and audio recording of lectures and review sessions without the consent of the instructor is prohibited. Unless explicit permission is obtained from the instructor, recordings of lectures and review sessions may not be modified and must not be transferred or transmitted to any other person. Electronic devices other than laptops (e.g., cell phones, recording devices) are not to be used during lectures or exams without prior permission of the instructor.

All class lectures and materials herein, including but not limited to, pre-recorded and live lectures, live discussions and discussion boards (and recordings thereof), posted course materials, visual materials that accompany lectures/discussions, and virtual whiteboard notes (collectively "Course Intellectual Property") remain the intellectual property of the faculty member or other third-parties. No individual may record, reproduce, screenshot, photograph, or distribute any Course Intellectual Property in partial or full-format without the permission of the professor. Any violation of this policy may subject the individual to disciplinary and/or legal action.

Subject to Change Statement: Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

Tentative Schedule:

Monday	Tuesday	Thursday	Friday
Jan 8th **1** Descriptive Statistics (Sections 1.1,1.2)	**9th** **2** Measuring Variability (Section 1.3)	**11th** **3** Estimation and Bias (Sections 8.1, 8.2)	**12th** **4** Finding Unbiased Estimators (Section 8.3)

Monday	Tuesday	Thursday	Friday
15th 5 **NO CLASS** *Martin Luther King Day*	**16th** 6 Standard Error (Section 8.3) **HW #1 Due on GS at 11:59PM (PST)**	**18th** 7 Confidence Intervals (Section 8.5)	**19th** 8 Large-Sample Confidence Intervals (Section 8.6)
22nd 9 Wilson's Adjustment **HW #2 Due on GS at 11:59PM (PST)**	**23rd** 10 Selecting the Sample Size (Section 8.7)	**25th** 11 Distributions in Statistics	**26th** 12 Small-Sample Confidence Intervals for μ and $\mu_1 - \mu_2$ (Section 8.8) **Project Part 1 Due In Class**
29th 13 Confidence Intervals for σ^2 (Section 8.9) **HW #3 Due on GS at 11:59PM (PST)**	**30th** 14 Confidence Intervals in R	**Feb 1st** 15 Midterm #1 Review	**2nd** 16 **MIDTERM #1**
5th 17 Relative Efficiency (Sections 9.1, 9.2) **HW #4 Due on GS at 11:59PM (PST)**	**6th** 18 Consistency (Section 9.3)	**8th** 19 Sufficiency (Section 9.4)	**9th** 20 The Rao-Blackwell Theorem and Minimum-Variance Unbiased Estimation (Section 9.5)
12th 21 The Method of Moments (Section 9.6) **HW #5 Due on GS at 11:59PM (PST)**	**13th** 22 The Method of Maximum Likelihood (Section 9.7)	**15th** 23 Elements of a Statistical Test (Sections 10.1, 10.2)	**16th** 24 Common Large-Sample Tests (Section 10.3) **Project Part 2 Due In Class**
19th 25 Common Large-Sample Tests (Section 10.3) **HW #6 Due on GS at 11:59PM (PST)**	**20th** 26 Calculating Type II Error and Finding the Sample Size for Z Tests (Section 10.4)	**22nd** 27 Midterm #2 Review	**23rd** 28 **MIDTERM #2**
26th 29 **NO CLASS** *Spring Break*	**27th** 30 **NO CLASS** *Spring Break*	**29th** 31 **NO CLASS** *Spring Break*	**Mar 1st** 32 **NO CLASS** *Spring Break*

Monday	Tuesday	Thursday	Friday
4th **33** Confidence Intervals and p-Values (Sections 10.5, 10.6) **HW #7 Due on GS at 11:59PM (PST)**	**5th** **34** Small-Sample Hypothesis Testing for μ and $\mu_1 - \mu_2$ (Section 10.8)	**7th** **35** The Matched-Pairs Experiment (Section 12.3)	**8th** **36** Testing Hypotheses Concerning Variances (Section 10.9)
11th **37** Power of Tests and the Neyman-Pearson Lemma (Section 10.10) **HW #8 Due on GS at 11:59PM (PST)**	**12th** **38** Likelihood Ratio Tests (Section 10.11)	**14th** **39** Midterm #3 Review	**15th** **40** **MIDTERM #3**
18th **41** The Method of Least Squares (Sections 11.1 - 11.3) **HW #9 Due on GS at 11:59PM (PST)**	**19th** **42** The Method of Least Squares (Sections 11.1 - 11.3)	**21st** **43** Properties of the Least Squares Estimators (Section 11.4)	**22nd** **44** Inferences Concerning the Parameters β_i (Section 11.5) **Project Part 3 Due In Class**
25th **45** Confidence and Prediction Interval (Sections 11.6, 11.7) **HW #10 Due on GS at 11:59PM (PST)**	**26th** **46** Correlation (Section 11.8)	**28th** **47** Nonlinear Models (Section)	**29th** **48** The Analysis of Variance Procedure (Sections 13.1, 13.2)
Apr 1st **49** Comparison of More Than Two Means: Analysis of Variance for a One-Way Layout (Sections 13.3, 13.4) **HW #11 Due on GS at 11:59PM (PST)**	**2nd** **50** Post-Hoc Tests	**4th** **51** χ^2 Goodness-of-Fit Test (Sections 14.1 - 14.3)	**5th** **52** 2×2 Contingency Tables (Section 14.4) **Project Part 4 Due In Class**
8th **53** $r \times k$ Contingency Tables (Section 14.5) **HW #12 Due on GS at 11:59PM (PST)**	**9th** **54** The Sign Test for a Matched-Pairs Experiment (Section 15.3)	**11th** **55** Midterm #4 Review	**12th** **56** **MIDTERM #4**

Monday	Tuesday	Thursday	Friday
15th **57** The Wilcoxon Signed-Rank Test for a Matched-Pairs Experiment (Section 15.4)	**16th** **58** The Mann–Whitney U Test: Independent Random Samples (Section 15.6)	**18th** **59** Project Day	**19th** **60** Project Day **Project Part 5 Due In Class**
22nd **61**	**23rd** **62** Section 1: **FINAL PRESENTATION** 10:30AM – 1:00PM	**25th** **63**	**26th** **64**

Note: This calendar is tentative. For up-to-date information, see the course page on Courses.