STA 506 Mathematical Statistics II

Spring 2026

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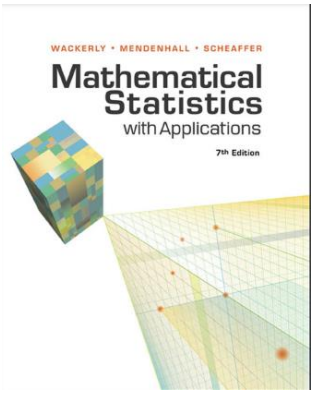
Course Web Page: D2L.

Class Meeting: Wednesday 5:45 PM - 8:30 PM in UNA 127

Office Hours: Tuesday / Thursday: 12:30 PM – 2:00 PM
Wednesday: 3:00 PM – 5:00 PM

Required Text (Optional): *Mathematical Statistics with Applications*, 7th edition, Wackerly, Mendenhall, and Scheaffer.



COURSE DESCRIPTION

Continuation of STA 505. Correlation, sampling, tests of significance, analysis of variance, and other topics. STA 506 Prerequisite: Successful completion of STA 504 or STA 505, with a minimum grade of C-.

PROGRAM STUDENT LEARNING OUTCOMES (PSLO) FOR MS IN APPLIED STATISTICS

1. Demonstrate an understanding of probability and statistical inference, including the fundamental laws of classical probability, discrete and continuous random variables, expectation theory, maximum likelihood methods, hypothesis testing, power, and bivariate and multivariate distribution theory.

2. Demonstrated the ability to apply the elementary methods of statistical analysis, namely those based on classical linear models, categorical methods, and non-parametric ideas, to perform data analysis for statistical inference.
3. Demonstrate proficiency in the effective use of computers for research data management and analysis of data with standard statistical software packages, particularly SAS.
4. Learn to develop and critically assess the design of experimental studies and the collection of data.
5. Apply one or more methods of statistical inference to a particular area of interest, particularly the program in the elective concentration.
6. Gain practical experience in statistical consulting and communicating with non-statisticians, culminating in interaction with research workers at a local company as part of the internship practicum.

COURSE STUDENT LEARNING OBJECTIVES

1. To systematically discuss sampling distributions and the Central Limit Theorem. [PSLO 1]
2. To introduce the basic ideas of both point and interval estimators. [PSLO 1, 2, 4]
3. To discuss the methods of moment and likelihood estimators in detail. [PSLO 1, 2, 4]
4. To illustrate logic and methods of testing hypotheses. [PSLO 1, 2, 4]
5. To discuss the linear regression models and their relevant inferences. [PSLO 1, 2]
6. To use R to implement some inferential problems [PSLO 1, 2, 3, 5]

POLICIES ON HOMEWORK

There will be regular homework assignments for this class. The assigned problems reflect the contents covered in the class. The following policies apply to the homework of this class.

- Late homework will not be accepted.
- You are expected to complete all assigned problems. I will randomly select a subset to be graded, and your homework score will be based on these. Detailed solutions for all assigned problems will be posted on the course website.
- **Collaboration**: You are encouraged to work together on homework problems. However, your final write-up must be your own work. Please adhere to the University's academic integrity policies (https://catalog.wcupa.edu/graduate/academic-policies-procedures/academic-integrity/)
- Please submit your homework as organized, neat, and stapled hard copies. You are required to prepare your homework using R Markdown.

POLICIES FOR USING GENERATIVE AI TOOLS

While there is no formal university-wide policy on generative AI, you can refer to WCU's Guiding Framework for its use (https://www.wcupa.edu/infoServices/generative-AI.aspx). In

this class, I encourage you to use AI tools to enhance your learning. However, you are strictly responsible for all submitted work, including any synthesized AI-generated content such as code, calculations, and derivations.

- *Submitting raw, unedited AI output is prohibited*. All assignments must demonstrate your personal synthesis, critical evaluation, and mastery of the underlying statistical concepts.

- You are expected to understand, verify, and take scholarly ownership of every element of your submission. *Any errors, inaccuracies, or violations of academic integrity stemming from AI-assisted content will be treated as your own*.

- Code Documentation Requirement: All submitted R code—whether written entirely by you, synthesized from AI-generated snippets, debugged with AI assistance, or otherwise created—must include detailed explanatory comments. These comments must focus on the why (the purpose, reasoning, or statistical logic) and not merely describe the what (the basic function of the command). This practice is essential for demonstrating your understanding.

EVALUATION & GRADING

The course grade will be based on

(1). Homework (50%) [PSLO 1,5; CSLO 1-6]
(2). Midterm Exams (20% each) [PSLO 1, 5; CSLO 1-3, 6]
(3). Final Comprehensive Exam (30%) [PSLO 1, 5; CSLO 3-6].

A letter grade will be assigned based on performance in the course, according to the following scale:

Grade	Quality Points	Percentage Equivalents	Interpretation
A	4.00	[93%, 100%]	Superior graduate attainment
A-	3.67	[90%, 93%)	
B+	3.33	[86%, 90%)	Satisfactory graduate attainment
B	3.00	[83%, 86%)	
B-	2.67	[80%, 83%)	
C+	2.33	[76%, 80%)	Attainment below graduate expectations
C	2.00	[73%, 76%)	
C-	1.67	[70%, 73%)	
F	0	< 70%	Failure

D grades are not used. Refer to the Graduate Catalog for a description of NG (No Grade), W, & other grades.

TENTATIVE TOPICS

The following is the list of tentative topics to be covered in the semester. I may modify and list as we move forward during the semester.

1. Introduction and Computing Tools
    - Course logistics and overview
    - R, RMarkdown, and GitHub

2. Distribution Functions
    - CDF and density functions
    - Concepts of reliability and lifetime distributions

3. Sampling Distributions
    - The exact sampling distributions: normal, t, χ^2, and F.
    - Asymptotic sampling distributions: normal and χ^2.

4. Empirical Distribution and Bootstrap Resampling
    - Nonparametric CDF
    - Parametric and non-parametric Bootstrap sampling

5. Methods of Moment Estimation
    - Concepts of estimation and estimators
    - Methods of Moment Estimation (MME)

6. Maximum Likelihood Estimation
    - Concepts of likelihood: complete and incomplete observations
    - Maximum likelihood estimation (MLE)

7. Properties of MLE
    - Score equation and Fisher Information matrix
    - Covariance matrix and asymptotic normality

Midterm Exam

8. Confidence Intervals
    - Pivotal quantity: exact vs approximate
    - Confidence intervals: symmetrical vs asymmetrical and equal vs unequal-tailed two confidence intervals.

9. Bootstrap Confidence Intervals
    - Bootstrap sampling of an estimator and framework of Bootstrap Confidence Intervals
    - Commonly used Bootstrap confidence intervals.

10. The logic of Statistical Hypothesis Testing
    - Statistical proof by contradiction
    - Type I & II errors and performance measures of a hypothesis test.

11. Likelihood-based Asymptotic Tests
    - Likelihood ratio test vs deviance test
    - Wald and Score chi-square tests

12. Bootstrap Testing Hypotheses
    - One- and two-sample Bootstrap tests
    - Asymptotic Bootstrap Chi-squared tests

13. Bayesian Framework
    - Bayes' Theorem and variants
    - Gaussian conjugate estimation

14. Bayesian Estimation and Naïve Bayes Prediction
    - Bayesian estimation and credible intervals
    - Prediction with Bayes and naïve Bayes

Final Exam: Wednesday, 5/6/26,

ACADEMIC & PERSONAL INTEGRITY

It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Graduate Handbook, the Graduate Catalog, the Ram's Eye View, and the University website.

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

West Chester University is committed to providing equitable access to the full WCU experience for Golden Rams of all abilities. Students should contact the Office of Educational Accessibility (OEA) to establish accommodations if they have had accommodations in the past or if they believe they may be eligible for accommodations due to a disability, whether or not it may be readily apparent. There is no deadline for disclosing to OEA or for requesting to use approved accommodations in a given course. However, accommodations can only be applied to future assignments or exams; that is, they can't be applied retroactively. Please share your letter from OEA as soon as possible so that we can discuss accommodations. If you have concerns related to disability discrimination, please contact the university's ADA Coordinator in the Office of Diversity, Equity, and Inclusion or 610-436-2433.

UNIVERSITY-EXCUSED ABSENCES POLICY

Students are advised to carefully read and comply with the University-Excused Absences Policy, including absences for university-sanctioned events, contained in the WCU Graduate Catalog. In particular, please note that the "responsibility for meeting academic requirements rests with the student," that this policy does not excuse students from completing required academic work, and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

REPORTING INCIDENTS OF SEXUAL VIOLENCE

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to comply with the requirements of Title IX of the Education Amendments of 1972 and the University's commitment to offering supportive measures in accordance with the new regulations issued under Title IX, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. **Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University Protection of Minors Policy.** Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth on the WCUPA Sexual Misconduct website.

INCLUSIVE LEARNING ENVIRONMENT AND ANTI-RACIST STATEMENT

Diversity, equity, and inclusion are central to West Chester University's mission as reflected in our Mission Statement, Values Statement, Vision Statement, and Strategic Plan: Pathways to Student Success. We disavow racism and all actions that silence, threaten, or degrade historically marginalized groups in the U.S. We acknowledge that all members of this learning community may experience harm stemming from forms of oppression, including but not limited to classism, ableism, heterosexism,

sexism, Islamophobia, anti-Semitism, and xenophobia, and recognize that these forms of oppression are compounded by racism.

Our core commitment as an institution of higher education shapes our expectations for behavior within this learning community, which represents diverse individual beliefs, backgrounds, and experiences. Courteous and respectful behavior, interactions, and responses are expected from all members of the University. We must work together to make this a safe and productive learning environment for everyone. Part of this work is recognizing how race and other aspects of who we are shape our beliefs and our experiences as individuals. It is not enough to condemn acts of racism. For real, sustainable change, we must stand together as a diverse coalition against racism and oppression of any form, anywhere, at any time.

Resources for education and action are available through WCU's Office for Diversity, Equity, and Inclusion (ODEI), DEI committees within departments or colleges, the student ombudsperson, and centers on campus committed to doing this work (e.g., Dowdy Multicultural Center, Center for Women and Gender Equity, and the Center for Trans and Queer Advocacy).

Guidance on how to report incidents of discrimination and harassment is available at the University's Office of Diversity, Equity, and Inclusion.

EMERGENCY PREPAREDNESS

All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. To report an emergency, call the Department of Public Safety at 610-436-3311.

ELECTRONIC MAIL POLICY

It is expected that faculty, staff, and students activate and maintain regular access to university-provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.