

# SIE 430/530 ENGINEERING STATISTICS – FALL 2025

(Tuesday and Thursday 8:00 – 9:15 AM)

## Instructor and Contact Information

|                      |                                                                               |
|----------------------|-------------------------------------------------------------------------------|
| <u>Instructor:</u>   | Dr. Jian Liu, Professor of the Department of Systems & Industrial Engineering |
| <u>Office:</u>       | ENGR 221                                                                      |
| <u>Email:</u>        | <a href="mailto:jianliu@email.arizona.edu">jianliu@email.arizona.edu</a>      |
| <u>Phone:</u>        | 520-621-6548                                                                  |
| <u>Office Hours:</u> | Tue. 7 – 8 PM or by Appointment                                               |

## Course Description and Overview

This course will provide senior undergraduate and graduate students and introduction to fundamental concepts, principles and tools to conduct statistical analysis in engineering applications. Students will explore statistical techniques used to analyze data and make informed decisions in engineering contexts. The course is composed of a systematic introduction of the fundamental topics of engineering statistics, including: (1) data characterization and probability theory, (2) theoretical basis for statistical inference, (3) modeling and algorithms, and (4) evaluation mechanisms. The emphasis is placed on understanding when and how to apply specific methods, interpreting results correctly, and recognizing the limitations of various statistical tools. Real-world engineering problems and data will be used as illustration examples.

## Course Objectives and Expected Learning Outcomes

The objective of this course is to prepare engineering students with fundamental knowledge for statistical data analysis. The primary objective of this course is to prepare engineering students with mathematical modeling and theoretical analysis training for statistical inference. Graduate students will develop deeper understanding of theoretical foundations of statistical inference. By taking this course, both **undergraduate** and **graduate** students will possess the capability to:

- (i) characterize and model data;
- (ii) understand the theoretical basis for statistical inference;
- (iii) apply methods and algorithms of statistical inference on engineering problems.

**For graduate** Students, additional learning outcomes include:

- (i) approaches to evaluating the inference methods and algorithms, and
- (ii) development of inference methods for given engineering problems.

## Course Prerequisites:

Advanced Standing: Engineering

## Reading Materials

**Lecture notes:** provided and can be downloaded from D2L course website

**Textbook:** G. Casella and R.L. Berger, *Statistical Inference*, 2<sup>nd</sup> ed., Duxbury Thomson Learning, Pacific Grove, CA, 2002.

**Course Website:** We will be using the D2L system. (<http://d2l.arizona.edu/>). All class materials, including HW, handouts, etc. will be distributed from D2L. I will also be sending emails to the whole class throughout the semester using the class list on D2L. Please make sure you forward your D2L email to an email account that you frequently use.

**Lecture videos** will be available after each lecture on D2L → UA Tools → Panopto.

**References:**

- D. Wackerly, W. Mendenhall and R.L. Scheaffer, *Mathematical Statistics with Applications*, 7<sup>th</sup> ed., Duxbury Press, Belmont, California, 2008.
- A. Gut, *An Intermediate Course in Probability*, Springer, New York, 1995.
- W.W. Hines, D. C. Montgomery, D. M. Goldsman and C.M. Borror, *Probability and Statistics in Engineering*, 4<sup>th</sup> ed., Wiley, Hoboken, New Jersey, 2003.
- R.V. Hogg, J.W. McKean and A.T. Craig, *Introduction to Mathematical Statistics*, 6<sup>th</sup> ed., Pearson Prentice Hall, Upper Saddle River, New Jersey, 2005.
- S. M. Ross, *First Course in Probability*, 6<sup>th</sup> ed., Prentice Hall, Upper Saddle River, New Jersey, 2001.

**Temporary Lecture Schedule:**

|         | Lecture and Topics                                                                                                                                                | Notes                                                  |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| Week 1  | Lecture 1: Introduction to general course information and fundamental data characterization<br>Lecture 2: Set theory, probability concept and counting techniques | Week 1 – Homework 1: due in the second class of Week 2 |
| Week 2  | Lecture 3: Conditional probability & Independence, concept of random variable<br>Lecture 4: Univariate & multivariate distribution model                          | Week 2 – Homework 2: due in the second class of Week 3 |
| Week 3  | Lecture 5: Marginal & conditional distribution model<br>Lecture 6: Expectation & variance                                                                         | Week 3 – Homework 3: due in the second class of Week 4 |
| Week 4  | Lecture 7: Covariance & conditional expectation, transformation<br>Lecture 8: Special distributions- discrete                                                     | Week 4 – Homework 4: due in the second class of Week 5 |
| Week 5  | Lecture 9: Special distributions - continuous<br>Lecture 10: Exponential family, moment & moment generation function (MGF)                                        | Week 5 – Homework 5: due in the second class of Week 6 |
| Week 6  | Lecture 11: Function of random vector, fundamental concepts of Statistics<br>Lecture 12: Samples from Normal distribution                                         | Week 6 – Homework 6: due in the second class of Week 7 |
| Week 7  | Lecture 13: Derived distributions<br>Lecture: Review for Exam I                                                                                                   | Week 7- Homework 7: due in the second class of Week 8  |
| Week 8  | Lecture 14: Order statistics & sufficiency principle<br>Lecture 15: Likelihood principle & point estimation                                                       | Exam I preparation – No Homework                       |
| Week 9  | Lecture: Practice exam I review<br>Exam I – In class (75 min)                                                                                                     | Exam I week - No Homework:                             |
| Week 10 | Lecture 16: Method of moment, maximum likelihood estimation                                                                                                       | Week 10- Homework 8: due in the second class of        |

|         |                                                                                    |                                                                |
|---------|------------------------------------------------------------------------------------|----------------------------------------------------------------|
|         | Lecture 17: Bayes estimation                                                       | Week 11                                                        |
| Week 11 | Lecture 18: Evaluating point estimators<br>Lecture 19: UMVUE                       | Week 11- Homework 9:<br>due in the second class of<br>Week 12  |
| Week 12 | Lecture 20: Hypothesis testing, LRT<br>Lecture 21: Evaluating hypothesis test      | Week 12- Homework 10:<br>due in the second class of<br>Week 13 |
| Week 13 | Lecture 22: Size & level of a test, p-value<br>Lecture 23: Tests for applications  | Week 13- Homework 11:<br>due in the second class of<br>Week 12 |
| Week 14 | Lecture 24: Interval estimation<br>Lecture 25: Applications of interval estimation | Week 14- No Homework                                           |
| Week 15 | Lecture: Exam II review                                                            | Exam II preparation – No<br>Homework                           |
| Week 16 |                                                                                    | Exam II                                                        |

*The above topics and schedule are subject to change. Revisions in the syllabus may occur as the semester progresses.*

**Homework:** The homework will be assigned on Thursdays and due on the following Thursday, before 11:59 PM. NO late submission is allowed unless it is requested and approved by the instructor in advance (e-mail or phone-call received before the day the assignment is due).

#### **Examinations:**

**Exam I:** October 30, 8:00 – 9:15 AM, for on-campus students (AME, S212), any 75-min time slot for distance learning students

**Exam II:** December 18, 8:00 – 9:30 AM for on-campus students (AME, S212), any 90-min time slot for distance learning students  
(detailed arrangements will be announced in class.)

Makeup examinations **MUST** be requested at least one week prior to the date the exam is held. In case of medical or other personal/family emergencies, a formal excuse (doctor's note, etc.) is required.

**Academic Integrity Policy:** Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, homework, and exams must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity: <http://dos.web.arizona.edu/uapolicies/>. Any violation of the academic integrity code will be dealt with using the procedures detailed in the code.

#### **Grading Scale and Grade Policy**

##### **I - Grading:**

Course grades for **undergraduate** section will be determined based on the following items.

| Course Work | Points | Percentage |
|-------------|--------|------------|
| Homework    | 25     | 20%        |
| Exam I      | 35     | 35%        |

|              |            |             |
|--------------|------------|-------------|
| Exam II      | 45         | 45%         |
| <b>TOTAL</b> | <b>100</b> | <b>100%</b> |

**Graduate students** will have additional advanced (sub)questions in assignments and examinations, which reflect higher requirements on the understanding of statistical modeling, inference, and evaluation. Course grades for the **graduate** section will be determined based on the following items.

| Course Work  | Points     | Percentage  |
|--------------|------------|-------------|
| Homework     | 25         | 20%         |
| Exam I       | 35         | 35%         |
| Exam II      | 45         | 45%         |
| <b>TOTAL</b> | <b>100</b> | <b>100%</b> |

The grading scheme will follow the distribution below. University policy regarding grades and grading systems is available at <http://catalog.arizona.edu/policy/grades-and-grading-system>.

| Points | Percentage | Letter Grade |
|--------|------------|--------------|
| 90-100 | 90%-100%   | <b>A</b>     |
| 80-89  | 80%-89%    | <b>B</b>     |
| 70-79  | 70%-79%    | <b>C</b>     |
| 60-69  | 60%-69%    | <b>D</b>     |
| <60    | <60%       | <b>E</b>     |

*There is no extra credit for any student.*

**Dispute of Grade Policy:** Students disputing a grade on any grade item (e.g., homework and exam) must do so within a week of the graded work being returned. Note: unexcused absences will not extend this deadline.

#### **Classroom attendance:**

- If you feel sick or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructors if you will be missing an in person or online course.

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <https://deanofstudents.arizona.edu/policies/attendance-policies-and-practices>. The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, see: <http://policy.arizona.edu/human-resources/religious-accommodation-policy>. Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <http://policy.arizona.edu/employmenthuman-resources/attendance>.

**Academic advising:** If you have questions about your academic progress this semester, or your chosen degree program, please note that advisors at the Advising Resource Center can guide you toward university resources to help you succeed.

**Life challenges:** If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or [DOS-deanofstudents@email.arizona.edu](mailto:DOS-deanofstudents@email.arizona.edu).

**Physical and mental-health challenges:** If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

**Remain flexible:** If pandemic conditions warrant, the University may require that we return to remote operations. If that is the case, we will notify you by D2L Announcement and email that we are moving to remote operations.

**Class Recordings:** Course recordings will be made for every lecture. If you do not wish to be identified by name, please contact the instructor immediately and solutions will be discussed according to FERPA Privacy Protection guide. For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies are subject to suspension or civil action.

### **Inclusive Excellence Statements**

This course supports elective gender pronoun use and self-identification; rosters indicating such choices will be updated throughout the semester, upon student request. As the course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. (NOTE: You can download your class roster from UAccess)

Inclusive Excellence is a fundamental part of the University of Arizona's strategic plan and culture. As part of this initiative, the institution embraces and practices diversity and inclusiveness. These values are expected, respected and welcomed in this course.

### **Threatening Behavior Policy**

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See: <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

### **Safety on Campus and in the Classroom**

For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): <https://cirt.arizona.edu/case-emergency/overview>

Also watch the video available at

[https://arizona.sabacloud.com/Saba/Web\\_spf/NA7P1PRD161/common/learningeventdetail/crtfy00000000003560](https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/common/learningeventdetail/crtfy00000000003560)

### **UA Nondiscrimination and Anti-harassment Policy**

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see: <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>.

**Accessibility and Accommodations (for students with Disability)**

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation.

If you have reasonable accommodations, please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

If our class meets at a campus location: Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable. Their website is <http://drc.arizona.edu/instructors/syllabus-statement>.

**Requests for incomplete (I) or withdrawal (W)** must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

**Additional Resources for Students**

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>  
Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

**Use of Generative AI**

This course is designed to build your original thinking, writing, and problem-solving skills, and using generative AI tools to replace this work would interfere with your learning. Therefore, using generative AI to complete graded assignments in this course will be considered a violation of the [Code of Academic Integrity](#), specifically the prohibition against submitting work that is not your own. If you have any questions or want to talk about using AI, please contact your instructor.

**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.