ECON 502 Economic Statistics
Course Syllabus
Credits: 4
Semester: Fall 2023
Meeting Times & Location:
Section M1: TR 9:30 am – 10:50 am room 1065 Lincoln Hall
Section M2: TR 11:00 am – 12:20 pm room 1028 Lincoln Hall

You can access the course outline **here** (last updated: 9:30 am, 08/28/2023). The course outline includes the topics covered in each lecture, as well as the due dates for assignments and exam dates. It is regularly updated to reflect the flow of the course. Please make sure to check the course outline on a regular basis to stay up-to-date with any changes or important information.

Instructor: Ali Toossi
Email: toossi@illinois.edu
Office Location: 205C David Kinley Hall
Office Hours: MW 2:00 pm-3:00 pm or by appointment.

TA Information: This course has two assistant instructors (AI). The AI's will hold a review session on Fridays. In these sessions, the AI will review the material covered in class, go over more examples, and answer your questions. The attendance in the review sessions is mandatory. If for any reason you are not able to attend, you must contact professor Toossi and get his permission not to attend. The assistant instructors will also hold daily office hours. You can also request individual appointments as needed.

The first meeting of Friday sessions will be on Friday August 25.

Jay Rafi (section M1):
Office: 110 DKH
E-mail: jaysar2@illinois.edu
Daily Office hours: MW: 10:30 am – 11:30 am; TR: 8:15 am – 9:15 am
Weekly Review Session: Friday 2:00 pm- 3:20 pm, 123 David Kinley Hall

Lovepreet Singh (section M2):
Office: 110 DKH
E-mail: ls12@illinois.edu
Daily Office hours: MW: 11:30 am – 12:30 pm; TR: 3:30 pm – 4:30 pm
Weekly Review Session: Friday 12:30 pm- 1:50 pm, 123 David Kinley Hall

Course Description: This course on Statistics and Probability offers an in-depth exploration of fundamental concepts and techniques in statistical analysis and probability theory. This course is designed to provide students with a solid foundation in statistical reasoning, data analysis, and probabilistic modeling. Throughout the course, students will delve into key topics such as probability distributions, hypothesis testing, and estimation. Emphasis will be placed on both theoretical understanding and practical implementation. By the end of the course, students will have a better understanding of statistical concepts, their applications, and the mathematical foundations underlying them.

Prerequisites: A background in undergraduate-level statistics and probability is recommended. Familiarity with mathematical concepts such as calculus will be advantageous. Basic programming skills for data analysis (using R) will also be beneficial.

Requirements Course Meets: This course is a mandatory core requirement for all MSPE students, essential for fulfilling the requirements of their master's degree.

Learning Outcomes: After completing this course, you should be able to:

Demonstrate knowledge and use of probability theory
Derive estimators for unknown parameters, and compare and evaluate estimators
Test hypothesis and confidence intervals for unknown parameters
Demonstrate a basic understanding of computer simulation
Apply concepts to practical problems and relate them to other coursework and experiences you've had in statistics

Canvas site: You can access the course syllabus, course outline, lecture notes, recorded lectures, assignments, sample exams, and your grades via the Canvas site created for this course. To login go to this link: https://canvas.illinois.edu/. I also have created a discussion board on Canvas. You can post your questions there and either me, Jay or Lovepreet will answer you as soon as possible.

Textbook/Other Required Materials
Required: Mathematical Statistics with Applications (7th ed.), by Dennis Wackerly, William Mendenhall III, Richard Scheaffer. Cengage Learning.
Note that eBook and rent print book options are also available. Go to: https://www.cengage.com/c/mathematical-statistics-with-applications-7e-wackerly/9780495110811/.
Recommended: Probability & Statistical Inference (9th ed.), by Hogg / Tanis / Zimmerman. https://www.pearson.com/us/higher-education/program/Hogg-Probability-and-Statistical-Inference-9th-Edition/PGM91556.html.

Software: You have to do some assignments using Excel and R. You can download the software R at this site: https://cran.r-project.org/. I will post a brief instruction on coding in R on the course Canvas site.
You can access the Excel and R software on the computers available in the university computer labs. These labs are equipped with the necessary tools to facilitate your learning and practice with both Excel and R during the course. Make sure to take advantage of these resources to enhance your understanding and proficiency in using these programs

Exams: This course will include the following Exams:
Midterm Exam: Tuesday October 3 during the class time
Final Exam: Friday December 8, 1:30 pm – 4:30 pm (Conflict Exam: Friday December 8, 8:00 am – 11:00 am)

It is the student's responsibility to confirm Exam dates, times, and locations. Final Exam Information is provided on the Course Explorer and Registrar's Website midway into the semester: https://registrar.illinois.edu/final-exam-schedule-public

Exam Conflicts will follow the Student Code Procedures:

Student Code Evening/Midterm/Hourly Exams: https://studentcode.illinois.edu/article3/part2/3-202/
Student Code Final Exams: https://studentcode.illinois.edu/article3/part2/3-201/

Grading:
The course grade will be determined as follows: Homework (25%) + Midterm (35%) + Final (40%)

Grade Cutoffs: A +/- scale will be used. The cut-offs for +/- are as follows (there will be adjustments based on the performance of the class):

A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-
≥97%	≥93%	≥89.5%	≥87%	≥83%	≥79.5%	≥77%	≥73%	≥69.5%	≥67%	≥63%	≥59.5%

I will adjust the average determined above to take into consideration the trend of your performance and grades.

Course Policies

Assignments: There will be a required homework assignment approximately every two weeks (7 homeworks). Each assignment consists of some problems and an Excel or R project. There will also be some optional problems assigned from the textbook. You do not need to turn in the optional problems, but I strongly recommend that you do them.

- The assignment with the lowest grade will be dropped.
- Assignments should contain the following information on the right-hand corner of the page: your name, assignment identification and date.
- I will post the assignments on the course Canvas site. For each assignment a deadline will be announced. You must upload your solution in Canvas. Any solutions submitted after the deadline will not be graded.

Exams: The class will have a midterm exam and a final exam. The midterm exam is scheduled to take place for one hour and 20 minutes during the class time, while the final exam is set to be three hours long. All exams are cumulative.

- You can use a simple calculator.
- There are to be no books, papers other than the exam itself.
- No cell-phone use is allowed during the exam. Students found to be using unapproved items are in violation of the Academic Integrity policy of the University and will be subject to disciplinary action.
- In case of an extreme circumstance such as illness, it is essential to inform me before the exam and provide appropriate documentation. However, please note that there will be no make-up exams under normal circumstances.

Attendance Policy: Attendance in the lectures and Friday review sessions is mandatory. If you encounter any emergencies that prevent you from attending either the lectures or Friday review

sessions, please make sure to contact Professor Toossi in advance. Communication in such situations is crucial to address any issues or concerns appropriately.
Student Code pertaining to student attendance:
https://studentcode.illinois.edu/article1/part5/1-501/
Office of the Dean of Students helps to assist students navigate the Student Code and course policies. If students will be absent for an extended period of time, they should discuss with this office: http://odos.illinois.edu/

Academic Assistance
Students are encouraged to utilize the many resources we have throughout campus to assist with academics. We recommend that you seek them out starting early in the semester, not just in times of academic need, in order to develop good study habits and submit work which represents your full academic potential. Many resources may be located on the Economics Website, including information about the Economics Tutoring Center, other tutoring centers: http://www.economics.illinois.edu/undergrad/resources/accassistance/

Academic Integrity
According to the Student Code, `It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.' Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, found here: https://studentcode.illinois.edu/article1/part4/1-401/
Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policies. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.
Read the full Student Code at the following URL: http://studentcode.illinois.edu/

Students with Disabilities
To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TTY), or e-mail a message to *disability@illinois.edu* DRES Website: www.disability.illinois.edu/

Emergency Response Recommendations
Emergency response recommendations can be found at the following website: http://police.illinois.edu/emergency-preparedness/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-actionplans/.

Family Educational Rights and Privacy Act (FERPA)
Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See http://registrar.illinois.edu/ferpa for more information on FERPA. Student information and records will not be released to anyone other

than the student unless the student has provided written approval or as required by law. More information may be found here: https://studentcode.illinois.edu/article3/part6/3-601/.

Sexual Misconduct Reporting Obligation
The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: http://www.wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: http://wecare.illinois.edu/.

Student Support
The Counseling Center is committed to providing a range of services intended to help students develop improved coping skills in order to address emotional, interpersonal, and academic concerns. Please visit their website to find valuable resources and services: https://counselingcenter.illinois.edu/.
Counseling Center Information: 217-333-3704
Location: Room 206, Student Services Building 610 East John Street, Champaign, IL
Appointment: Scheduled for same day, recommend calling at 7:50 a.m.
McKinley Mental Health Information: 217-333-2705
Location: 3rd Floor McKinley Health Center 1109 South Lincoln, Urbana, IL
Hours: 8 a.m. – 5 p.m., Monday through Friday Appointment: Scheduled in advance.

Emergency Dean
The Emergency Dean may be reached at (217) 333-0050 and supports students who are experiencing an emergency situation after 5 pm, in which an immediate University response is needed, and which cannot wait until the next business day. The Emergency Dean is not a substitute for trained emergency personnel such as 911, Police or Fire. If you are experiencing a life-threatening emergency, call 911. Please review the Emergency Dean procedures: https://odos.illinois.edu/community-of-care/emergency-dean/

Academic Dates and Deadlines
Students should make note of important academic dates for making changes to their courses (add, drop, credit/no-credit, grade replacement, etc.). https://registrar.illinois.edu/academic-calendars
Please check with your academic department regarding specific procedures and policies.

The course outline lists the dates each topic will be covered.
The dates are approximate & could change.

Lecture	Date	Topics Covered
1	August 22	**Chapter 1: What is statistics?** Descriptive & Inferential Statistics Population or Process, Sample Strategies for collecting data: Random, stratified, cluster Sampling
2	August 24	**Chapter 1: What is statistics?** (*Continued*) Types of studies: experimental/Observational Types of observational Data: Cross section, Time series, Panel "natural" experiments Types of Data: Quantitative vs Qualitative Quantitative: discrete vs Continuous **Descriptive statistics:** Quantiles, mean (Arithmetic, Geometric), trimmed mean, median
3	August 29	**Chapter 1: What is statistics?** (*Continued*) **Descriptive statistics:** mode, range, interquartile range, Variance, CV, MAD, Empirical Rules, Skewness, Kurtosis, JB test for normality, **Chapter 2: Probability** Set theory: Definition, Venn diagram, subset, union, intersection
4	August 31	**Chapter 2: Probability** Set theory: complements, partition, distribution law, De Morgan's law random experiments, sample space (Discrete, Continuous); event (simple, compound) Def. of probability=> 3 approaches: 1-probability as proportion of desired to possible outcomes, 2- probability as relative frequency 3- axiomatic approach, Using axiomatic approach to derive some results
Tuesday	**Sept. 5**	**First Homework Due**
5	September 5	**Chapter 2: Probability** (*Continued*)

		Using axiomatic approach to derive some results **Calculating probability of event**: *Sample point method* Tools for counting: multiplication rule, permutation, combination, examples on counting Binomial coefficients
6	September 7	**Chapter 2: Probability** (*Continued*) Multinomial coefficients Event Composition Method for calculating probabilities of events: additive law of probability Conditional probability Multiplicative law of probability
7	September 12	**Chapter 2: Probability** (*Continued*) Independence & conditional independence of events **Calculating probability of event**: *event composition method* Examples Using table to solve problems
8	September 14	**Chapter 2: Probability** (*Continued*) Example on "event composition method" The law of total probability & Bayes' rule Examples on Bay's rule Simple random sampling Random variable: definition RV types: discrete, continuous
Asynchronously Recorded Video (1)	**September 14**	**Chapter 2:** **examples on Bay's rule** **Simple random sampling** **Random Variable (RV): Definition,** **Discrete & continuous RV**
Saturday	**Sept. 16**	**Second Homework Due**
9	September 19	**Chapter 3: Discrete random variables** Random variable and its realization P(Y=y) Discrete probability distribution expected value: mean, variance mean & variance of a function of a random variable Examples on expected value and variance

		Bernoulli experiment & related distributions Bernoulli Distribution Binomial Distribution: Definition and formula Binomial Distribution: as sum of Bernoulli random variables, Mean, variance
Recorded Video (2)	**September 20**	**Chapter 3: Discrete PDF (*Continued*)** **More examples on Binomial** **Hypergeometric** **Geometric** **Negative binomial**
10	September 21	**Chapter 3: Discrete random variables (continued)** *Review* Bernoulli experiment is the foundation of the following probability mass functions: Bernoulli, binomial, hypergeometric, geometric, negative binomial Poisson: as an approximation of binomial distribution, as a probability distribution for the Poisson process
11	September 26	**Chapter 3: Discrete random variables (continued)** Examples on Poisson Distribution Moments: uncentred and centered (about the mean) Moment generating functions
12	September 28	**Chapter 3: Discrete random variables (continued)** Example on MGF Tchebysheff's Theorem **Chapter4: Continuous random variables** Cumulative Distribution function (CDF) Discrete Y: CDF ➔STEP function (right Continuous) + non decreasing
Sunday	**October 1**	**Third Homework Due**
Monday	**7:00 pm October 2**	**Zoom: Exam 1 Review session**
Midterm 1	**Tuesday October 3**	**During class time**
13	October 5	**Chapter4: (continued)** Continuous Y: CDF ➔Continuous function

		Continuous Y: Probability Density Function Relation between CDF & PDF Example on PDF & CDF Expected value & Variance of Continuous RV The uniform PD
recorded video (3)	**October 5**	**Solving extra examples on continuous distributions + uniform & Normal distributions**
Friday Review Session	**October 6**	**Example: uniform distribution (7th 4.44 page 176)** **Normal PD + Examples on Normal:** (7th, 4.58, page 181) + (7th, 4.63, page 182)
14	October 10	**Chapter4: (continued)** Example on how to find CDF of uniform distribution Normal distribution How to use standard normal table The Gamma PD Relationship between Gamma and Poisson Gamma Special cases: Chi-square, Exponential Relationship between Exponential and Poisson
recorded video (4)	**October 10**	**Chapter4: Relationship between Gamma & Poisson** **Relationship between Exponential & Poisson** **Hazard function**
15	October 12	**Chapter4: (continued)** Memoryless property of exponential Example on Exponential Beta Distribution MGF for continuous RV Tchebysheff's theorem for continuous RV **Chapter 5: Bivariate PD (discrete)** Joint probability distribution
Tuesday	**October 17**	**4th Homework Due**
16	October 17	**Chapter 5: Bivariate PD (discrete)**

		Cumulative probability distribution Marginal & conditional probability distributions Independent random variables, Expected value of a function of random variables conditional expectations Example on bivariate discrete distributions Covariance & Correlation
recorded video (5)	**October 17**	**Chapter5:** simple linear regression & Correlation Expected value & variance of sample proportion Law of large numbers for sample mean & sample proportion Bivariate probability distribution (Continuous RVs) Introduction to double integration Example on double integration
17	October 19	**Chapter 5: Bivariate PD (discrete)** Example on correlation Regression (OLS) & correlation expected value and variance of a linear function Expected value & variance of sample mean Expected value & variance of sample proportion Law of large numbers for mean and proportion **Chapter 5: Bivariate probability distributions (continuous)** Joint Distribution function & density function
recorded video (6)	**October 19**	***Chapter 5: Bivariate probability distributions (continuous)*** **Examples on Bivariate continuous variables and conditional expectations**
18	October 24	**Chapter 5: Bivariate probability distributions (continuous)** Marginal & conditional probability distributions Independent random variables

		Expected value of a function of random variables Conditional expectations Example on conditional expectation Law of iterated expectations
19	October 26	Bivariate normal **Chapter 6: Functions of random variables (sections 6.1-6.5)** method Distribution function Method of Transformations Examples
recorded video (7)	**October 26**	**More Examples on chapter 6**
20	October 31	**Chapter 6: Functions of random variables (sections 6.1-6.5)** Method of MGFs Examples on Finding distribution of sample mean using method of MGF **Chapter 7: Sampling distribution & the CLT** Definition of Statistics Sampling distribution of sample mean and sample variance (**Watch video 8**)
recorded video (8)	**October 31**	**Chapter 7: Sampling distribution & the CLT** Definition of statistic Definition of sampling distribution Sampling distribution of: sample mean (when population variance is known) sampling distribution of sample variance t-student distribution sampling distribution of sample mean (when population variance is unknown) F distribution Sampling distribution of ratio of two sample variances (from two populations) Examples on Sampling Distributions Normal approximation to the binomial Examples on approximation of binomial by standard Normal

		Central limit theorem Examples on CLT
21	November 2	**CHAPTER 7:** Definitions of distributions t-student & F Examples
Sunday	**November 5**	**Fifth Homework Due**
recorded video (10)		**Solution to some problems in assignment 5 + Sample exam 2**
22	November 7	**Chapter 7:** Normal approximation of Binomial Central limit theorem (Watch video 8) **Chapters 8 & 9** **8.2**: properties of point estimators: The bias and mean square error
23	November 9	**Chapters 8-9:** **Problem 9.8 (page 448):** Cramer-Rao Theorem: Find the minimum variance of unbiased estimators **9.3:** Consistent estimators **Chapter 9:** **9.4:** Sufficiency Likelihood function and factorization criterion Functions of Exponential forms
recorded video (9)		**Chapter 8: Estimation (sections 8.1 to 8.4)** Point estimation, Estimators Properties: Bias, mean square error **Chapter 9: More on point estimates** Relative efficiency Cramer-Rao theorem (page 448) Examples on Cramer-Rao
Recorded Video (11)		**Chapter 9:** More explanation & example on sufficiency
24	November 14	**Chapter 8-9:** Lehman-Scheffe Theorem and its application **9.6:** Estimation method: moments Examples on Method of moments **9.7:** Estimation method: maximum likelihood

		Examples on Method of maximum likelihood **Chapter 8 revisited** Example on MLE for uniform distribution **8.5:** Confidence intervals (CI) **8.6:** large sample CI for the mean and proportion **8.8:** Small sample confidence interval for: the mean & difference of means
Recorded Video (12)		**Chapter 9:** Examples on Factorization criterion Examples on "distribution of exponential forms", "application of Lehman-Scheffe theorem" & "method of moments"
Recorded Video (13)		**Chapter 9:** **Example on MLE** **Chapter 8 (revisited):** **Examples on large sample confidence intervals**
25	November 16	**8.9:** Confidence interval for the variance Example on CI for population variance **Chapter 10: Hypothesis Testing** Introduction to Hypothesis Testing *How to construct RR* Type I and Type II errors Alpha, beta and Power of tests Power function Example on Power Function
Recorded Video (14)	**November 16**	**Chapter 10:** **Review of the following concepts** Type I and Type II errors Alpha, beta, and Power of tests Power function *How to construct RR*
	Nov 18 – Nov 26	**Fall Break**
Recorded Video (15)	**Watch during Break**	**Chapter 10: Hypothesis Testing** *Simple vs composite hypothesis* *Neyman Pearson Lemma* *Examples on N-P Lemma* Uniformly Most Powerful Tests
recorded video (16)	**Watch during Break**	**Chapter 10: Hypothesis Testing** Example on Power Function

		Likelihood ratio tests with an example
recorded video (17)	**Watch during Break**	**Chapter 10: Hypothesis Testing** *Example on Likelihood ratio tests* The recipe for doing large sample tests
26	November 28	**Chapter 10: Hypothesis Testing** *Simple vs composite hypothesis* *Neyman Pearson Lemma* *Examples on N-P Lemma* Uniformly Most Powerful Tests Example on Neyman-Pearson Lemma Examples on large sample tests
27	November 30	**Chapter 10: Hypothesis Testing** p-values Examples on p-values Relation between CI and HT Small sample tests Testing hypothesis about population variance *Testing hypothesis about variances of two populations*
recorded video (18)	**December 1**	**Chapter 10: Hypothesis Testing** More examples on large and small samples Relationships between HT & CI HT concerning variances
28	December 5	**Review Session:** Solving Examples
Wednesday	**Dec. 6**	**6th Homework Due**
	December 7	Reading Day: No Class
Thursday	**4:00 pm December 7**	**Zoom: Final Exam Review session**
Final Exam:	***Friday, December 8***	**Exam will start at 1:30 pm** **(Conflict exam starts at 8:00 am)**