ECON 502 Economic Statistics
Course Syllabus
Credits: 4
Semester: Fall 2024
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 1068 Lincoln Hall

You can access the course outline **here** (last updated: 1:20 pm, 09/05/2024). 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 30.
Lovepreet Singh (section M1):
Office: 110 DKH
E-mail: **ls12@illinois.edu**
Daily Office hours: MW: 11:00 am-noon; TR: 4:30 pm - 5:30 pm, room 110 DKH
Weekly Review Session: Friday 2:00 pm- 3:20 pm, 123 David Kinley Hall
Jay Rafi (section M2):
Office: 110 DKH
E-mail: **jaysar2@illinois.edu**
Daily Office hours: MW:2:00 pm - 3:00 pm; TR: 3:30 pm - 4:30 pm, room 110 DKH
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:
1) *Mathematical Statistics with Applications* (7th ed.), by Dennis Wackerly, William Mendenhall III, Richard Scheaffer. Cengage Learning.
For more information & purchase options go to: https://www.cengage.com/c/mathematical-statistics-with-applications-7e-wackerly/9780495110811/Links to an external site.
2) *Data Analysis for Social Science: A Friendly and Practical Approach* , by Elena Llaudet, Kosuke Imai. Princeton university press
For more information & purchase options go to: https://press.princeton.edu/books/paperback/9780691199436/data-analysis-for-social-scienceLinks to an external site.

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.htmlLinks to an external site.

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 8 during the class time
***Final Exam*:** Friday December 13, 1:30 pm – 4:30 pm (*Conflict Exam*: Friday December 13, 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 27	**Chapter 1: What is statistics?** Descriptive & Inferential Statistics Population or Process, Sample 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
2	August 29	**Chapter 1: What is statistics?** (*Continued*) **Descriptive statistics:** Quantiles, mean (Arithmetic, Geometric), median, mode, range, interquartile range, Variance, CV, Empirical Rules, Skewness, Kurtosis
3	Sept 3	**Chapter 1: What is statistics?** (*Continued*) Example using R **Chapter 2: Probability** Set theory: Definition, Venn diagram, subset, union, intersection, 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
4	Sept 5	**Chapter 2: Probability** Def. of probability=> 3 approaches: 2- probability as relative frequency 3- axiomatic approach, Using axiomatic approach to derive some results **Calculating probability of event**: additive law of probability (when events are not mutually exclusive) Conditional probability Multiplicative law of probability

		Independence & conditional independence of events
5	September 10	**Chapter 2: Probability** (*Continued*) Using table to solve problems. The law of total probability & Bayes' rule Examples on Bay's rule Tools for counting: multiplication rule, permutation, combination, examples on counting Binomial coefficients Multinomial coefficients
Recorded Video (1)		**Chapter 2:** **examples on Bay's rule**
Tuesday	**Sept. 10**	**First Homework Due**
6	September 12	**Chapter 2: Probability** (*Continued*) *Two methods for calculating probabilities:* *Sample point method* (Examples) Event Composition Method (Examples) Random variable: definition RV types: discrete, continuous Random variable and its realization P(Y=y) Discrete probability distribution Examples
7	September 17	**Chapter 2: Probability** (*Continued*) expected value: mean, variance mean & variance of a function of a random variable Examples on expected value and variance
8	September 19	**Chapter 2: Probability** (*Continued*) Bernoulli experiment & related distributions Bernoulli Distribution Binomial Distribution: Definition and formula **Chapter 3: Discrete random variables** Binomial Distribution: as sum of Bernoulli random variables, Mean, variance
Recorded Video (2)	**September 19**	**Chapter 3: Discrete PDF (*Continued*)** **More examples on Binomial** **Hypergeometric +Example** **Geometric + Examples**

		Negative binomial + Examples
Sunday	**Sept. 22**	**Second Homework Due**
9	September 24	Examples on binomial, hypergeometric, geometric, negative binomial
10	September 26	**Chapter 3: Discrete random variables (continued)** Poisson: as an approximation of binomial distribution, as a probability distribution for the Poisson process Examples on Poisson Distribution Moments: uncentred and centered (about the mean)
11	October 1	**Chapter 3: Discrete random variables (continued)** Moment generating functions Example on MGF Tchebysheff's Theorem **Chapter4: Continuous random variables** Left limit, right limit, Continuity, right continuity, left continuity
12	October 3	**Chapter4: Continuous random variables** Cumulative Distribution function (CDF) Discrete Y: CDF ➔STEP function (right Continuous) + non decreasing Continuous Y: CDF ➔Continuous function Continuous Y: Probability Density Function Relation between CDF & PDF Example on PDF & CDF
Sunday	**October 6**	**Third Homework Due**
Monday	**7:00 pm October 7**	**Zoom: Midterm Review session**
Midterm 1	**Tuesday October 8**	**During class time**
13	October 10	**Chapter4: (continued)** Expected value & Variance of Continuous RV The uniform PD 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
recorded video (3)	**October 10**	**Solving extra examples on continuous distributions + uniform & Normal distributions**
14	October 15	**Chapter4: (continued)** Gamma Special cases: Chi-square, Exponential Relationship between Exponential and Poisson Memoryless property of exponential Example on Exponential Hazard Function
recorded video (4)	**October 15**	**Chapter4: Relationship between Gamma & Poisson** **Relationship between Exponential & Poisson** **Hazard function**
15	October 17	**Chapter4: (continued)** More on hazard function Beta Distribution MGF for continuous RV Tchebysheff's theorem for continuous RV **Chapter 5: Bivariate PD (discrete)** Joint probability distribution Cumulative probability distribution Marginal & conditional probability distributions Independent random variables,
Thursday	**October 17**	**4th Homework Due**
16	October 22	**Chapter 5: Bivariate PD (discrete)** Expected value of a function of random variables conditional expectations Example on bivariate discrete distributions Covariance & Correlation Example on correlation Regression (OLS) & correlation expected value and variance of a linear function Expected value & variance of sample mean

recorded video (5)	**October 22**	**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 24	**Chapter 5: Bivariate PD (discrete)** Expected value & variance of sample proportion Law of large numbers for mean and proportion **Chapter 5: Bivariate probability distributions (continuous)** How to do double integration Joint Distribution function & density function Marginal & conditional probability distributions Independent random variables Expected value of a function of random variables
recorded video (6)	**October 24**	***Chapter 5: Bivariate probability distributions (continuous)*** **Examples on Bivariate continuous variables and conditional expectations**
18	October 29	**Chapter 5: Bivariate probability distributions (continuous)** Independent random variables Expected value of a function of random variables Conditional expectations Example on conditional expectation Law of iterated expectations Bivariate normal **Properties:** Marginal distributions are normal Conditional distributions are normal Conditional expectation is linear (OLS gives the same conditional expectation function) Conditional variance is constant If correlation is zero, the two variables are independent

19	October 31	**Chapter 6: Functions of random variables (sections 6.1-6.5)** method Distribution function Method of Transformations Examples Method of MGFs Example
recorded video (7)	**October 31**	**More Examples on chapter 6**
20	October 31	**Chapter 6: Functions of random variables (sections 6.1-6.5)** Method of MGF(Continued): 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 Definition of t-student distribution Application (**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

Sunday	November 3	Fifth Homework Due
21	November 5	**CHAPTER 7:** Definitions of distributions t-student & F Examples Normal approximation of Binomial Central limit theorem (Watch video 8)
22	November 7	**Chapter 7:** Examples on CLT **Chapters 8 & 9** **8.2**: properties of point estimators: Error of estimation The bias and mean square error Example: Sample variance is an unbiased estimation of population variance.
23	November 12	**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 (10)		**Chapter 9:** More explanation & example on sufficiency
24	November 14	**Chapter 8-9:** Lehman-Scheffe Theorem and its application **9.6:** Method of moments Examples on Method of moments **9.7:** Method of maximum likelihood Examples on Method of maximum likelihood **8.5:** Confidence intervals (CI)

Recorded Video (11)		**Chapter 9:** Examples on Factorization criterion Examples on "distribution of exponential forms", "application of Lehman-Scheffe theorem" & "method of moments"
Recorded Video (12)		**Chapter 9:** **Example on MLE** **Chapter 8 (revisited):** **Examples on large sample confidence intervals**
25	November 19	**8.6:** large sample CI for the mean and proportion **8.8:** Small sample confidence interval for: the mean & difference of means **8.9:** Confidence interval for the variance Example on CI for population variance
Friday Extra lecture	November 22	**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 *Simple vs composite hypothesis* *Neyman Pearson Lemma* *Examples on N-P Lemma*
Recorded Video (13)	**November 19**	**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*
Recorded Video (14)	**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 (15)	**Watch during Break**	**Chapter 10: Hypothesis Testing** Example on Power Function *Likelihood ratio tests with an example*
recorded video (16)	**Watch during Break**	**Chapter 10: Hypothesis Testing** *Example on Likelihood ratio tests* The recipe for doing large sample tests

	Nov 23 – Dec 1	**Fall Break**
26	Dec 3	**Chapter 10: Hypothesis Testing** *More examples on N-P Lemma* large sample tests with examples p-values Examples on p-values Relation between CI and HT
27	Dec 5	**Chapter 10: Hypothesis Testing** Small sample tests Testing hypothesis about population variance *Testing hypothesis about variances of two populations*
Thursday	**Dec 5**	**Bonus Homework Due (optional)**
recorded video (17)	**December 5**	**Chapter 10: Hypothesis Testing** More examples on large and small samples Relationships between HT & CI HT concerning variances
28	December 10	Solving Examples on Hypothesis testing
Wednesday	**Dec. 10**	**6th Homework Due**
	December 11	Reading Day: No Class
Thursday	**4:00 pm**	**Zoom: Final Exam Review session**
Final Exam:	***Friday December 13***	**1:30-4:30 pm** **Make-up exam: 8:00-11:00 am**