Statistics 615 – Introduction to Stochastic Processes

Section 600, Spring Term, 2024

updated 9 December 2023

This course is an introductory theoretical survey of basic stochastic processes (without measure theory), including countable state Markov processes, Poisson point processes, renewal processes and Brownian motion. Emphasis is on establishing and using the primary results. Applied examples and problems are included but *this is not an applied stochastic processes course*.

Although we do not discuss statistical applications per se, the material is very relevant for modern statistics. In particular, the following areas rely heavily on stochastic processes of one sort or another: time series, Bayesian methods, spatial statistics, longitudinal clinical trials, biostatistics and functional data analysis.

Stochastic processes also have many useful applications in computer science, engineering, economics, the geosciences and other fields. Such applications can be quite sophisticated, but they ultimately rely on the principles presented in this course.

Course Information (*Tentative*)

Time and Place:	MWF 9:10pm–10:00am, Blocker 448.
Instructor:	Daren Cline. (http://stat.tamu.edu/~dcline)
Office:	Blocker 459D, 845-1443.
E-mail:	dcline@stat.tamu.edu
Office Hours:	MWF 10:20am–11:20am, or by appointment.
Canvas:	http://canvas.tamu.edu. Lecture notes and homework assignments will be available at Canvas. Please bring the notes to class.
Text:	S.I. Resnick, *Adventures in Stochastic Processes*, Birkhäuser (*required*).
References:	(on reserve in Evans Library) • M.A. Berger, *An Introduction to Probability and Stochastic Processes*, Springer. • R.N. Bhattacharya and E.C. Waymire, *Stochastic Processes with Applications*, Wiley. • E. Çinlar, *Introduction to Stochastic Processes*, Prentice-Hall. • E.P.C. Kao, *An Introduction to Stochastic Processes*, Duxbury. • S. Karlin and H.M. Taylor, *A First Course in Stochastic Processes*, Academic Press. • M. Kijima, *Markov Processes for Stochastic Modeling*, Chapman & Hall. • S.M. Ross, *Stochastic Processes, 2nd ed.*, Wiley.
Prerequisite:	*Statistics 610 (or 630) and Mathematics 409 (or 615) or their equivalent.* The statistics requirement includes • theory of probability distributions for random variables and random vectors, • expectations, moments and variance, • conditional distributions and conditional expectations, • probability generating functions and moment generating functions, • probability and moment inequalities, • the law of large numbers and the central limit theorem. The mathematics requirement is advanced calculus, specifically • knowing how to produce careful, rigorous proofs, • sequences, limits and power series, • continuity, differentiability and Taylor's expansion, • integrals, Laplace and Fourier transforms, • uniform convergence and uniform continuity. Previous exposure to stochastic processes is not required.

Course Information (continued)

Computing:	You are encouraged to make use of a computing language or software (such as Matlab or R, your choice) for homework. A calculator will be helpful for exams.
Homework:	Homework will be assigned (on the course web page) and collected regularly. Homework is worth 30% of the total term score. *Please see the homework policy below.*
Exams:	One midterm exam worth 30% and a final exam worth 40%. *Please see the exam policy below.*
Exam Dates:	Midterm Exam: Friday, 8 March (*tentative*). Final Exam: Friday, 3 May, 8:00am–10:00am. Students may not take the final exam early; so please do not even ask.
Grading:	80% A, 65% B, 50% C, or at my discretion.
Disabilities Help:	The Americans with Disabilities Act (ADA) provides civil rights protection for persons with disabilities and guarantees a learning environment with reasonable accommodation of their disabilities. If you believe you have a disability and need accommodation, please contact me and Disability Services in the Student Services at White Creek complex on west campus, or call 979-845-1637.
Academic Integrity:	You are expected to maintain the highest integrity in your work for this class, consistent with the Aggie Honor Code and the university rules on academic integrity. This includes not passing off anyone else's work as your own, even with their permission. Please see the homework and exam policies below for specifics.
Copyright:	Each document provided on my web pages or by me is copyrighted with all rights reserved, whether or not the document explicitly states so. They may only be used for academic purposes and they may not be reproduced or sold without my permission. You may refer to them for other classes or for research, just as you would any book, as long as you give proper credit and neither you nor anyone else reproduces them for sale or other distribution. To use some of the material for instruction purposes, you need to first get written permission from me (Daren Cline, TAMU Department of Statistics, College Station TX 77845-3143).

Course Outline

Topic (by chapter in the text)

1. **Introduction** (weeks 1–2)
2. **Countable State Markov Chains** (weeks 3–6)
3. **Renewal Processes** (weeks 7–9)
4. **Point Processes** (weeks 10–12)
5. **Countable State Markov Processes** (week 13)
6. **Brownian Motion** (week 14, time permitting)

Course Policies

Homework Policy:

Your homework solutions must be your own work, not from outside sources, consistent with the university rules on academic integrity. I expect you to follow this policy scrupulously. *Your performance on the exams is much more likely to be better.* (Also, relying on others' solutions will cause me to think I can ask harder questions on the exams!)

You may use:

- Your textbook and notes from class.
- Your notes, homework, etc., from a related class that you took or are taking.
- References listed on the syllabus.
- Discussion with me.
- *Voluntary, mutual and cooperative* discussion with other students currently taking the class. This does not mean copying from each other.

You may not use:

- Solutions manuals (printed or electronic) other than what is provided with the required texts.
- Solutions from previous classes.
- Solutions, notes, homework, etc., from students who took the class previously.
- Solutions, notes, homework, etc., from classes taught elsewhere or at another time.
- Copying from students in this class, including expecting them to reveal their solutions in "discussion". That is, you may work together as indicated above as long as you work out and prepare your own solutions.

Homework is to be submitted by the end of class on its due date unless I specify otherwise. *Late homework is not acceptable.*

Exam Policy:

Your exam solutions must be your own work, using only resources I explicitly allow, consistent with the university rules on academic integrity.

No exam may be taken early or made up, except if you provide a university excused absence with appropriate documentation.

Each exam will be comprehensive and cumulative.

- Please bring your own paper (blank on both sides). I ask that separate problems be on separate sheets.
- Bring resources (such as notes) only if I explicitly allow them.
- You may use a calculator for numerical calculations only. The calculator *may not be part of, associated with or connected to any communication device*, such as a cell phone, iPod, tablet or laptop.

I will not expect you to quote theorems and results explicitly but I do expect you to demonstrate that you can make correct use of them. Specifically, you will need to:

- Show all your work. This does not necessarily mean showing every individual algebraic or calculus step – but it must be clear what those steps would be.
- Identify (by number, name or description) any theorems, examples or homework problems you use.
- Verify conditions and assumptions as needed for those theorems and examples.
- Clearly identify the solution and/or the end of a proof or derivation.

Selected problems from my old exams will be available on the course web page. However, their content may not exactly match this semester's exams.

Makeup Policy:

This is based on university policy.

- Exams and homework can be made up only if you must miss due to illness, university excused absence or other reason I may excuse at my discretion. Notify me or the Statistics Department (before, if feasible, otherwise within two working days after you return) to schedule the make-up.
- An Incomplete will be given only in the event you have completed most of the course but circumstances beyond your control cause prolonged absence from class and the work cannot be made up.

Texas A&M System Mandated Statements

- **Statement On Disabilities** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation for their disabilities. If you believe you have a disability requiring an accommodation, please contact the Office of Disabilities Services in Disability Services building at the Student Services at White Creek on the Main Campus. Their phone number is 979-845-1637. For additional information go to the website disability.tamu.edu.
- **Statement On Plagiarism** As commonly defined, plagiarism consists of passing off as one's own ideas, words, writing, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."
- **Academic Integrity Statement** "An Aggie does not lie, cheat, or steal or tolerate those who do." The Aggie Honor Council Rules and Procedures are available at aggiehonor.tamu.edu.
- **Title IX and Statement on Limits to Confidentiality** Texas A&M University and the College of Science are committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws provide guidance for achieving such an environment. Although class materials are generally considered confidential pursuant to student record policies and laws, University employees — including instructors — cannot maintain confidentiality when it conflicts with their responsibility to report certain issues that jeopardize the health and safety of our community. As the instructor, I must report (per Texas A&M System Regulation 08.01.01) the following information to other University offices if you share it with me, even if you do not want the disclosed information to be shared: *Allegations of sexual assault, sexual discrimination, or sexual harassment when they involve TAMU students, faculty, or staff, or third parties visiting campus.* These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In many cases, it will be your decision whether or not you wish to speak with that individual. If you would like to talk about these events in a more confidential setting, you are encouraged to make an appointment with the Student Counseling Service (https://scs.tamu.edu/). Students and faculty can report non-emergency behavior that causes them to be concerned at http://tellsomebody.tamu.edu.
- **Statement on Mental Health and Wellness** Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.
- **Personal Illness and Quarantine** Students required to quarantine must participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence

(See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student's medical provider is preferred, for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.

- **Copyright Notice** Faculty members own copyright in their educational work at Texas A&M University, as stated in the Texas A&M University System Policy for Intellectual Property Management and Commercialization (http://policies.tamus.edu/17-01.pdf). Students are not allowed to post or share any materials created by a faculty member unless given permission by that faculty member. This includes but is not limited to homework assignments, homework solutions, exams, exam solutions, lecture notes and any other supplemental materials. Any violation of this copyright policy could result in disciplinary actions as described in Student Rule 20.2: Procedures in Scholastic Dishonesty Cases and Student Rule 20.1.2.3.1 Texas A&M complies fully with the Digital Millennium Copyright Act ("DMCA"). Users of the Texas A&M network found to have engaged in repeated infringement of copyright are subject to termination of their network access and may be reported to the appropriate Dean or Human Resources officer for disciplinary action. Please see TAMU's Copyright Infringement Policies and Sanctions Notification for additional information (https://security.tamu.edu/protect myself/Copyright Infringement Policies and Sanctions Notifications.php).