

**UNIVERSITY OF KENTUCKY
COLLEGE OF ARTS AND SCIENCES**

**Course Syllabus
STA 624-001 Applied Stochastic Processes
Spring 2018**

Course meetings: Tuesdays & Thursdays 9:30-10:45 a.m. in MDS 337

Beginning 11 January and ending 26 April.
None on 13 March and 15 March.

Contact information

Instructor: Dr. Richard Charnigo, Professor of Statistics and Biostatistics
MDS 203, 725 Rose Street, Lexington KY 40536

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E-mail is generally a better way to reach me than phone. Ordinarily I am able to reply within one working day. To reduce the chance that your e-mail is mistaken for spam (of which I receive no little quantity), always include "STA 624" in the subject line. If you attach a file (PDF only, please), do not use TNEF encoding; see {<https://support.microsoft.com/en-us/kb/278061>}.

Office Hours: By appointment.

Internet: www.richardchnigo.net

Course description

Definition and classification of stochastic processes, renewal theory and applications, Markov chains, continuous time Markov chains, queueing theory, epidemic processes, Gaussian processes.

Course prerequisites

STA 524 or STA 623 or consent of instructor.

Course objectives

You will become familiar with applications and/or problem solving involving:

1. computation of expectations and probabilities by conditioning;
2. Markov Chain models in discrete and continuous time;
3. Poisson processes;
4. renewal theory; and,
5. Brownian motion.

Textbooks and Other Materials

1. The following textbook is required for the course:

Ross, Sheldon M. (2014). *Introduction to Probability Models*, 11th edition. Amsterdam: Elsevier.

2. I will post some materials for this course at {www.richardcharnigo.net/STA624S18}. The course website will be activated by the first day of class and will remain accessible for at least a few months after the course concludes. Please visit the website at least once a week this semester, to take note of any updates; doing so on Monday night is probably “optimal”, in that materials may not always be posted more than 24 hours in advance. If you wish to have hard copies of any documents from the course website, please print them.

Course requirements and learner evaluation

Team Projects: There will be four team projects for you to complete outside of class. They will be due at the end of class on the Thursdays of 08 February, 22 February, 05 April, and 19 April.

You may work in a self-selected team of two or three enrolled students, or you may work individually. You may stay with the same team all semester, or you may work in different teams for different projects. You may discuss the projects with anyone you wish, including other teams, but each team must prepare and is responsible for its own submitted work. Moreover, each team member is obliged to contribute to the problem-solving process on each item within a project and to understand the response which has been submitted for grading. A “divide and conquer” approach, whereby the different team members assume sole responsibility for various subsets of items, is not acceptable. (For example, you cannot “assign” exercise 1 to person A, exercise 2 to person B, and so forth.) Finally, you are expected to briefly acknowledge any classmates whose insights informed your work, if those classmates are not co-authors of the submitted work.

Team projects are ordinarily to be submitted in hard copy, to me in person or under my office door (MDS 203). If some compelling reason requires electronic submission, please make sure that your e-mail attachment is in PDF format and not TNEF encoded (see {<https://support.microsoft.com/en-us/kb/278061>}) and that the subject line includes “STA 624”. You may be asked to re-submit a team project which arrives as “winmail” due to TNEF encoding, and the due dates will not be extended for this reason. In any event, please retain your own copy of all team projects submitted for grading.

Midterm Examination: You will complete an individual take-home midterm examination, which will be due at the end of class on Thursday 08 March. You may not discuss the midterm examination with anyone, except to ask me for clarification if you do not understand a question. In addition, you may only consult Internet sources which existed before the midterm examination; for example, you may not create, or ask anyone else to create, new material related to the midterm examination in an online forum.

Midterm examinations are to be submitted in hard copy, to me in person or under my office door (MDS 203). If some compelling reason requires electronic submission, please make sure that your e-mail attachment is in PDF format and not TNEF encoded (see {<https://support.microsoft.com/en-us/kb/278061>}) and that the subject line includes “STA 624”. You may be asked to re-submit a midterm examination which arrives as “winmail” due to TNEF encoding, and the due date will not be extended for this reason. In any event, please retain your own copy of the midterm examination.

Final Examination: You will complete an individual take-home final examination, which will be due at 10:45 a.m. on Thursday 03 May. You may not discuss the final examination with anyone, except to ask me for clarification if you do not understand a question. In addition, you

may only consult Internet sources which existed before the final examination; for example, you may not create, or ask anyone else to create, new material related to the final examination in an online forum.

Final examinations are to be submitted in hard copy, to me in person or under my office door (MDS 203). If some compelling reason requires electronic submission, please make sure that your e-mail attachment is in PDF format and not TNEF encoded (see {<https://support.microsoft.com/en-us/kb/278061>}) and that the subject line includes "STA 624". You may be asked to re-submit a final examination which arrives as "winmail" due to TNEF encoding, and the due date will not be extended for this reason. In any event, please retain your own copy of the final examination.

Grading Components: Each of the four team projects will count for 150 points. The midterm examination will count for 200 points. The final examination will count for 200 points, yielding a total of 1000 points. Outstanding participation, such as (correctly) answering one of my questions in class or correcting me in a (substantial) mistake, will be acknowledged with a post-it note. Place your name and the calendar date on the post-it note, and submit it at the end of class for extra credit: 1 bonus point in each instance, up to a limit of 75 bonus points for the semester. Students accumulating at least 900 points in total (including bonus points) and 300 points on the two examinations (not including bonus points) will receive an official letter grade of "A". The cutoffs are 750 points and 240 points for an official letter grade of "B". The cutoffs are 600 points and 220 points for an official letter grade of "C". (An official letter grade of "D" is not available.)

Instructor expectations

1. I expect you to attend essentially all classes. Missing up to three or four class sessions for legitimate reasons is not a problem. However, missing several class sessions undermines your efforts to fulfill the course objectives. Please note that, whether present or absent, you are responsible for all material and announcements conveyed in a class session.
2. I expect not just your attendance but also your active involvement. You are always welcome to ask me questions during class. I will often pose questions myself, which you will be invited to answer. You may also send me e-mail if you have questions.
3. I expect you to keep a positive attitude throughout the semester. Timely feedback about what works well this semester and what does not work well will be appreciated.
4. You are permitted to make audio recordings of class sessions to aid your study and/or that of your classmates, provided that: (a) this is done discreetly; (b) this is not used as substitute for attending class, except when missing a class is otherwise necessary for a legitimate reason; and, (c) recordings are not made public or used for financial or commercial gain. Video recordings are not permitted unless required as a University-prescribed academic accommodation, in which case the above conditions apply as well as a restriction on the scope of the video to include only that part of the room from which the instructor speaks.
5. Please do not engage in extended text messaging or in any phone conversations during class. Up to one minute of texting for a sufficiently important and urgent reason is not a problem for me, provided it is done inconspicuously; if you need more than that, you are free to quietly step outside the classroom to handle your business.
6. You are expected to check the course webpage at least once a week (preferably on Monday night) and to check the e-mail address under which you registered for the course at least three times a week. As a courtesy, I will add alternate e-mail addresses to my mailing list upon

request. You are responsible for all material and announcements conveyed by e-mail; a full mailbox or bouncing of messages by your e-mail provider does not excuse this responsibility.

7. Graded material will ordinarily be available for retrieval on the Tuesday following its submission. If you do not retrieve graded material at the appointed time, I will keep it in my office for you to pick up later. If you wish to appeal my grading, you may present your appeal to me in person or submit it to me in writing, but this must be done within one week of the time that the graded material is initially made available for retrieval.

8. You are encouraged to skim the appropriate textbook material before we cover it in class and then study some portions of it more closely (as needed) afterward; do not expect a 75-minute class session by itself to imbue you with all of the knowledge that you will need or want.

Academic Policies

The student is responsible for being informed concerning all regulations and procedures required by the program of study, College, and University. Students should become familiar with the Graduate School Bulletin (<http://www.research.uky.edu/gs/CurrentStudents/bulletin.html>) and other program-specific materials (e.g., program handbooks) as appropriate. Academic disputes will be addressed in accord with policies contained therein, which are formally incorporated into this document by reference.

The College of Public Health, in which I also have an appointment, has compiled several policies at (<http://www.uky.edu/publichealth/student-resources/academic-policies>). Policies that are available include:

- Academic Integrity
- Accommodations Due to Disability
- Religious Observances
- Inclement Weather
- Excused Absences Policy
- Verification of Absences
- Student Resources

I hereby adopt the aforementioned policies in STA 624, with the following two modifications: The part about “work must be done by the student, and the student alone” is not applicable to the team projects, and the part about “may discuss assignments among themselves or with an instructor or tutor” is not applicable to the midterm and final examinations.

Late work policy

Cases involving any of the following will be handled individually: excused absences (including those related to religious observances), University-prescribed academic accommodations, and recommendations for special consideration from the office of an appropriate Dean or the Ombud. Otherwise, late work will be accepted at 75% of the credit otherwise earned if submitted within 24 hours of the due date. Late work will not be accepted if submitted after 24 hours.

Course schedule and topics

A tentative course schedule is shown below. Adjustments are likely, since this is the first time I have taught STA 624 since 2005.

Tuesday	Thursday
	January 11 2.9: Stochastic Processes
January 16 3.4: Computing Expectations by Conditioning	January 18 3.5: Computing Probabilities by Conditioning
January 23 3.6: Some Applications	January 25 4.1: Introduction
January 30 4.2: Chapman-Kolmogorov Equations	February 1 4.3: Classification of States
February 6 4.4: Long-Run Proportions, Limiting Probabilities	February 8 <i>Team Assignment 1 due</i> 4.5: Some Applications
February 13 4.6: Mean Time Spent in Transient States	February 15 5.1: Introduction
February 20 5.2: The Exponential Distribution	February 22 <i>Team Assignment 2 due</i> 5.3: The Poisson Process
February 27 5.4: Generalizations of the Poisson Process	March 1 6.1: Introduction
March 6 6.2: Continuous-Time Markov Chains	March 8 <i>Individual Midterm due</i> 6.3: Birth and Death Processes
March 13 SPRING BREAK	March 15 SPRING BREAK
March 20 6.4: The Transition Probability Function $P_{ij}(t)$	March 22 6.5: Limiting Probabilities
March 27 7.1: Introduction	March 29 7.2: Distribution of $N(t)$
April 3 7.3: Limit Theorems and Their Applications	April 5 <i>Team Assignment 3 due</i> 7.4: Renewal Reward Processes
April 10 10.1: Brownian Motion	April 12 10.2: Hitting Times, etc.
April 17 10.3: Variations on Brownian Motion	April 19 <i>Team Assignment 4 due</i> 10.6: White Noise
April 24 10.7: Gaussian Processes	April 26 10.8: Stationary and Weakly Stationary Processes
May 1 FINALS WEEK	May 3 <i>Individual Final due</i> FINALS WEEK

Other Course-Related Information

While I try to be thorough in preparing documents such as this, occasionally unforeseen contingencies arise. For example, what penalty should be imposed if a team project is completed by four persons instead of the maximum of three persons? That actually happened one semester with another course, and my answer is that I would discount the score by 25%. However, other similar questions can be proposed. I cannot anticipate all of them in advance. So, instead of trying to provide a document that is absolutely loophole-free, I will simply augment what is already written with the following: If a contingency arises that requires a new policy, or if some clarification is warranted, then I will make an appropriate announcement in class or by e-mail, either to the class generally or to the affected parties specifically.