School of Engineering and Applied Science
Department of Electrical and Computer Engineering

ECE 6711 – Probability and Stochastic Processes
Fall 2019

This syllabus may be found on the course website on UVaCollab: 19F ECE 6711 (ENGR).

Time and Location:

Lecture: TuTh 12:30PM – 1:45PM, Thornton Hall E304

Office Hours: Mondays, 2-3 PM; Wednesdays, 5-6 PM; or by appointment

Instructor:

Daniel Weller, Assistant Professor of Electrical and Computer Engineering.

Office: Rice Hall 309
Phone: 434-924-4271
Email*: dsw8c@virginia.edu

* To call attention to your email, please put "ECE 6711" somewhere in the subject line.

Course Staff:

Teaching assistant: Tingyang Meng

Course Description:

This course introduces fundamental concepts of probability and stochastic processes frequently encountered in the fields of signal processing, communications, controls, and computer engineering. Applications from these fields will reinforce these concepts through practical examples in lectures, assignments, and quizzes.

From the registrar:

> Topics include probability spaces (samples spaces, event spaces, probability measures); random variables and vectors (distribution functions, expectation, generating functions); and random sequences and processes; especially specification and classification. Includes detailed discussion of second-order stationary processes and Markov processes; inequalities, convergence, laws of large numbers, central limit theorem, ergodic, theorems; and MS estimation, Linear MS estimation, and the Orthogonality Principle. Prerequisite: APMA 3100, MATH 3100, or equivalent.
>
> Credits: 3

Textbook:

This course **requires** the following textbook:

John A. Gubner. *Probability and Random Processes for Electrical and Computer Engineers*. 1st Edition. Cambridge, 2006. ISBN: 978-0521864701.

Note: There is another textbook of the same name by Charles Therrien and Murali Tummala. That textbook has different content and exercises than what we will be using.

Here is a short list of additional references that may be helpful.

1. Robert G. Gallager. *Stochastic Processes: Theory for Applications*. Cambridge, 2014.
2. Geoffrey Grimmett and David Stirzaker. *Probability and Random Processes*. Oxford, 2001.
3. Alberto Leon-Garcia. *Probability, Statistics, and Random Processes For Electrical Engineering*. Pearson, 2008.
4. Athanasios Papoulis and S. Unnikrishna Pillai. *Probability, Random Variables, and Stochastic Processes*. McGraw Hill, 2002.
5. Roy D. Yates David J. Goodman. *Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers*. Wiley, 2014.

Grading:

This course will be graded based on student performance on assignments and examinations, as follows:

In-class activities:	10% (total)
7 Homeworks:	25% (total)
Midterm exam:	25%
Final exam:	40%
Total:	100%

In-class activities will reinforce the lectures through individual and group exercises and assessments. These activities are meant to provide practice and feedback on key concepts covered in the lectures or in the textbook, and grading will reflect mainly successful completion of these activities (and not necessarily correctness). Homework assignments will build on these exercises with more in-depth questions of varying difficulty. The midterm and final exams will test the learning of the concepts covered through the course. The in-class activities and homework assignments are designed to help prepare for these tests.

The midterm exam will be given during class time on Tuesday, October 15, which also corresponds to the SEAS Drop Deadline. The final exam will be given at the time set by the university registrar:

2:00PM – 5:00PM, Wednesday, December 11

Please try to limit travel or other business during exam times. If illness or another timing conflict arises, please arrange to make up the exam as soon as possible. If you fail to make up the exam in a timely manner, a grade of zero will be assigned.

Late Assignments: Please hand in assignments on time, at the beginning of class on the due date. Assignments handed in the same day (up to 5PM) after the start of class will be subject to a 10% penalty. Homework handed in before 5PM the next day will have a 20% late penalty. After that time, late homework will not be accepted (= 0 grade). Exemptions to this policy (e.g., due to illness) may be granted only by Prof. Weller, and only in advance of the deadline.

Software/hardware requirements: Some of the in-class activities and homework assignments will feature MATLAB, which students can obtain from UVA Information Technology Services. Visit `https://its.virginia.edu/` and search for MATLAB for more information.

Other Policies:

Use of electronic devices: Please refrain from using electronic devices in class except for course-related activities like note-taking or demonstrations. Laptops, tablets, and phones can distract those sitting near or around you.

Grading disputes: Please communicate with Prof. Weller or the TA regarding grading disputes. We are human and do make mistakes! To ensure timely release of course grades, please resolve any such disputes in advance of the final exam.

Accessibility: The University of Virginia strives to provide accessibility to all students. If you require an accommodation to fully access this course, please contact the Student Disability Access Center (SDAC) at (434) 243-5180 or sdac@virginia.edu. If you are unsure if you require an accommodation, or to learn more about their services, you may contact the SDAC at the number above or by visiting their website at `https://www.studenthealth.virginia.edu/sdac`.

Preventing Violence and Assault: The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. To that end, it is vital that you know two values that I and the University hold as critically important:

1. Power-based personal violence will not be tolerated.
2. Everyone has a responsibility to do their part to maintain a safe community on Grounds.

If you or someone you know has been affected by power-based personal violence, more information can be found on the UVA Office for Equal Opportunity and Civil Rights website that describes reporting options and resources available: `https://eocr.virginia.edu/`.

As your professor and as a person, know that I care about you and your well-being and stand ready to provide support and resources as I can. As a faculty member, I am a responsible employee, which means that I am required by University policy and federal law to report what you tell me to the University's Title IX Coordinator. The Title IX Coordinator's job is to ensure that the reporting student receives the resources and support that they need, while also reviewing the information presented to determine whether further action is necessary to

ensure survivor safety and the safety of the University community. If you would rather keep this information confidential, there are Confidential Employees you can talk to on Grounds (See `https://eocr.virginia.edu/chart-confidential-resources`). The worst possible situation would be for you or your friend to remain silent when so many here are willing and able to help.

Religious Accommodations: It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements.

Students who wish to request academic accommodation for a religious observance should submit their request in writing directly to me by email as far in advance as possible. Students who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the University's Office for Equal Opportunity and Civil Rights (EOCR) at UVAEOCR@virginia.edu or 434-924-3200.

Accommodations do not relieve you of the responsibility for completion of any part of the coursework missed as the result of a religious observance.

Honor Code: I trust every student in this course to fully comply with all of the provisions of the University's Honor Code. By enrolling in this course, you have agreed to abide by and uphold the Honor System of the University of Virginia, as well as the following policies specific to this course.

- Students are permitted to work in groups on homework assignments, but must individually complete and turn in homework write-ups.
- Computer programs must be individually written.
- Use of and copying from homework solutions from previous semesters will be considered an Honor Violation.
- Be careful to cite references when necessary and to avoid plagiarism. Plagiarism includes copying written material and copying computer software.
- Examinations are pledged and are strictly individual work.

All suspected violations will be forwarded to the Honor Committee, and you may, at my discretion, receive an immediate zero on that assignment regardless of any action taken by the Honor Committee.

Please let me know if you have any questions regarding the course Honor policy. If you believe you may have committed an Honor Offense, you may wish to file a Conscientious Retraction by calling the Honor Offices at (434) 924-7602. For your retraction to be considered valid, it must, among other things, be filed with the Honor Committee before you are aware that the act in question has come under suspicion by anyone. More information can be found at `https://honor.virginia.edu/`. Your Honor representatives can be found at: `https://honor.virginia.edu/representatives`.

Course Outline: *(Subject to change.)*

1. Probability and random variables
   - Set theory
   - Probability space, axioms of probability
   - Conditional probability, Bayes' rule, independent events
   - Random variables
   - Cumulative distribution function, probability mass function (discrete), probability density function (continuous)
   - Expectation, moments
   - Conditional distributions, conditional expectation
   - Derived distributions
   - Random vectors and matrices, multivariate Gaussian
   - Parameter estimation
2. Convergence of random variables; stochastic processes
   - Sequences and convergence of random variables
   - Laws of large numbers, central limit theorem
   - Random processes
   - Poisson counting process, Gaussian process
   - Markov process/chain
   - Random processes through linear systems
3. Estimation and expansion of random processes
   - Karhunen-Loève expansion
   - Markov chain Monte Carlo, Gibbs sampling