ECE 4784/6784
Wireless Communications
Spring 2022

Time and Location:

Lectures:

- Time: TuTh 3:30pm – 4:45pm.
- Location: Thornton Hall D223.

Office Hours:

- Time: TuTh 5:00pm – 6:00pm (i.e., after class).
- Location: Thornton E-317.

Website:

- Collab (if you do not have access, email me).

Instructor:

Cong Shen
Assistant Professor
Electrical and Computer Engineering
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Teaching Assistant:

Xizixiang Wei
PhD student
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Course Description:

This is an entry-level course on wireless communications. Primary emphasis will be upon wireless channel modeling, digital modulation and detection, synchronization, equalization for ISI channels, and wireless standards ranging from WiFi 802.11 series to cellular 5G. The goal is to teach fundamental and core techniques that enable physical layer wireless communications.

Textbooks:

Required:

- Upamanyu Madhow, *Fundamentals of Digital Communications*, Cambridge University Press, 2008.

References:

- A. Goldsmith, *Wireless Communications*, Cambridge University Press, 2005. (Online available at the author's Google Scholar page)
- D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005.
- M. P. Fitz, *Fundamentals of Communications Systems*, McGraw-Hill, 2007.
- G. Stuber, *Principles of Mobile Communications*, Springer, 2017.

Important Notes:

- The primary textbook has changed from last year.
- The materials in the (required and optional) textbooks are broader and deeper than what is covered in this class. Students are encouraged to read all materials but for the purpose of this course can focus on the chapters/sections that are most related to the lectures. I will try to highlight the relevant sections in the lectures.

Prerequisites:

An undergraduate-level understanding of probability (APMA 3100), linear algebra (APMA 3080) is assumed. Signals and systems, digital communications (ECE 4710), stochastic process (ECE6711), and information theory (ECE 6717) are preferred but not required. Students are also expected to have working knowledge of at least one of the common programming languages (Matlab, Python, C/C++, etc). I will be using Matlab for most of the examples. Please come and talk to me if you are unsure of your background.

This course is heavily focused on **algorithm and technology**. Students are expected to be comfortable with complicated mathematical derivations. We expect to have a mixture of PowerPoint presentations and "blackboard writing", with the latter being the main channel of education.

Course Outline:

1. A Review of probability and random processes (Appendix A)
2. Modulation (Chapter 2)
3. Demodulation (Chapter 3)
4. Synchronization and noncoherent communication (Chapter 4)
5. Channel equalization (Chapter 5)
6. Wireless communication (Chapter 8)

This outline may be subject to change, depending on the progress.

Grading:

This course will be graded based on student's performance on 3 homework assignments, 2 tests (in class), and 1 project, with the following percentages.

3 Homeworks:	30% (total)
Test 1:	30%
Test 2:	40%
Project:	40% (ECE 6784) or 15% (ECE 4784)
Total:	100% or 115%, no normalization (ECE 4784) 140%, will have normalization (ECE 6784)

- Graduate students who register under ECE 6784 are expected to have a mandatory project. **Undergraduate students who register under ECE 4784 do not have to do the project**, but you will earn the extra credit (15%) if you choose so. Graduate students who register under ECE 6784 are expected to have the mandatory project.
- There are 3 homework assignments. See the course outline table for detailed schedule. Homework assignment will be posted on Collab before Monday's lecture, and **the cutoff time for turning in your homework is before the lecture of the next Monday**, i.e., you have (roughly) one week to submit your homework. Each student is expected to complete the homework all by him/herself. The only allowed discussion is with the instructor or TA.
- Both tests are 70 minutes long and will be in one of the lectures. They are open book.
- **Letter grades** will be assigned as follows:

  93=A / 90=A- / 87=B+ / 83=B / 80=B- / 77=C+ /
  73=C / 70=C- / 67=D+ / 63=D / 60=D- / below=F

  These thresholds may move downward to reflect the actual difficulty of the class, and they will be separated for 4784 (undergraduate) and 6784 (graduate). Also, note that the grading for 6784 sums to 140%, which will be scaled back to 100%. The 4784 portion however will not – meaning that the student's grade can max out at 115%.
- **Late Assignments**: As stated before, the homework is expected to be submitted to the TA before the start of Monday lecture in the week following the assignment (unless otherwise stated by the instructor). This means you should expect to submit your HW before 2:00pm. Assignments submitted in the same day (before 11:59PM) after the start of class will be subject to a 10% penalty; after 11:59PM of Monday and before 11:59PM of Tuesday will be subject to a 25% penalty; after 11:59PM of Tuesday will be subject to a 100% penalty (i.e., 0 grade). Exceptions to this policy can be granted only by the instructor, and only before the deadline. **The project report is due at the end of the last lecture on 5/3. Any delay after that results in a zero grade.**
- **Grading disputes**: Please contact the instructor and/or the TA regarding any grading dispute. It is suggested that you try to resolve any such dispute well before the Thanksgiving week so that the final course grades can be released on time.

- **Software**: Many of the class activities, homework assignments, and project will feature *Matlab*, which students can obtain from UVA Information Technology Services. Visit https://its.virginia.edu/ and search for MATLAB. It is also possible for the students to use other software for the many tasks in this course, but Matlab is the default.

Other Policies:

Students with disabilities or learning needs

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Students with disabilities may also wish to work with the Student Disability Access Center to discuss a range of options to removing barriers in this course, including official accommodations. Please visit their website for information on this process and to apply for services online: sdac.studenthealth.virginia.edu. If you have already been approved for accommodations through SDAC, please send me your accommodation letter and meet with me so we can develop an implementation plan together.

Discrimination and power-based violence

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 Sexual Violence website that describes reporting options and resources available - www.virginia.edu/sexualviolence.

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 wish to report something that you have seen, you can do so at the **Just Report It** portal (http://justreportit.virginia.edu/). **The worst possible situation would be for you or your friend to remain silent when there are so many here 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 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.

Honor

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.

- All graded assignments must be pledged.
- Students must individually complete and turn in homework write-ups.
- Computer programs must be individually written.
- 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 http://honor.virginia.edu. Your Honor representatives can be found at: http://honor.virginia.edu/representatives.