EEL 6535 - Digital Communications
Spring 2018

Syllabus

1. **Catalog Description (EEL 6535):** (3 credits) Digital modulation techniques; analysis of digital communication systems in presence of noise; optimum principles; synchronization; equalization.

2. **Pre-requisites:** EEE 5544, computer programming (Python or MATLAB)

3. **Course Objectives:** Upon completion of this course, the student should be able to

   - design receivers for arbitrary signal sets on additive Gaussian noise channels
   - determine the error probabilities for communications over an AWGN channel
   - evaluate tradeoffs between bandwidth and energy efficiency
   - design and evaluate the performance of coherent and noncoherent receivers
   - explain the terms fading, nonselective, frequency-selective, time-selective
   - evaluate the performance of modulation in fading channels with and without diversity
   - understand various carrier and symbol synchronization techniques
   - understand and evaluate the performance of multi-antenna communication schemes, including beamforming and Alamouti code (modulation)
   - understand ISI and techniques to combat it in time and frequency

4. **Contribution of course to meeting the professional component:** *Does not apply*

5. **Relationship of course to program outcomes:** *Does not apply*

6. **Instructor:** Dr. John M. Shea

   (a) Office: 439 NEB
   (b) Phone: (352)575-0740 (Text messaging is encouraged for short questions or to schedule an appointment)
   (c) Email: jshea@ece.ufl.edu
   (d) Web site: http://wireless.ece.ufl.edu/jshea
   (e) Office hours: Tuesday 3:30 PM – 5:00 PM, Thursday 4:15 PM – 5:30 PM, or by appointment (text (352)575-0740)

7. **Teaching Assistant:** None

8. **Meeting Times:** 1:55 PM–2:45 PM, Tuesday/Thursday, 3:00 PM–3:50 PM Thursday

9. **Class/laboratory schedule:** 3 classes/week, 50 minutes each

10. **Meeting Location:** CSE E122

11. **Class Response System:**

    Both on-campus and off-campus students will need to use Learning Catalytics to complete interactive activities during the class. However, off-campus students must enroll in the off-campus section of Learning Catalytics. The cost is $12 per semester. Sign up here:

    https://learningcatalytics.com/

12. **Material and Supply Fees:** Students pay a fee for taking a course that is offered on EDGE. Students are required to have an account with the selected classroom response system provider.

13. **Recommended Textbook:** Upamanyu Madhow, *Fundamentals of Digital Communication*, Cambridge University Press, 2008 (ISBN 978-0-521-87414-4).

14. **Suggested References:**

    - John G. Proakis, *Digital Communications*, McGraw-Hill, 5th ed., 2008 (ISBN 978-0-07-295716-7).
    - Michael B. Pursley, *Introduction to Digital Communications*, Prentice Hall, 2005 (ISBN 0-201-18493-1).
    - Marvin K. Simon, Sami M. Hinedi, and William C. Lindsey, *Digital Communication Techniques: Signal Design and Detection*, Prentice Hall, 1995 (ISBN 0-13-200610-3).

15. **E-Learning:** All students must use the class web site, which is on E-Learning in Canvas: https://elearning.ufl.edu/.

16. **Computational Tools: Some problems will require Jupyter Notebook and Python with NumPy (all free software).** Details on recommended distributions and versions will be posted to the course website.

    MATLAB may be used as an alternative for some problems. MATLAB is available on the ECEL cluster. As departmental computer resources are limited, students may want to purchase the student version of MATLAB or install GNU Octave, which is a free MATLAB replacement.

17. Course Topics (as time allows):

    - Optimal Filtering, Decisions, and Signal Sets ($\sim$ 10 lectures)
    - Coherent Communications ($\sim$ 6 lectures)
    - Noncoherent Communications ($\sim$ 4 lectures)
    - Synchronization ($\sim$ 4 lectures)
    - Intersymbol Interference and Equalization ($\sim$ 6 lectures)
    - Fading Channels ($\sim$ 3 lectures)

- Multi-antenna Communication ($\sim$ 4 lectures)
- Multi-channel Communication ($\sim$ 3 lectures)

18. **Attendance and Expectations:** Attendance will not be taken. However, the classroom response system will be used to ask questions in almost every class. Students can respond using their smart phone, tablet, or laptop. The responses will affect on-campus students' grades. In addition, students are expected to know all material covered in class, even if it is not in the book.

19. **Grading:** Grading will be based on two exams (35% each), classroom responses and quizzes (15%), selected homework problems (10%), and participation (5%). The participation score for EDGE students will take into account in-class participation, e-mail or messaging exchanges, discussions outside of class, etc.

   Homework sets will be graded on a spot-check basis: if I give ten problems, we may only grade two of them. Homework will be accepted late once, with an automatic 25% reduction in grade.

   No formal project is required, but, as mention above, students will be required to use Python or MATLAB in solving some homework problems.

   When students request that a submission (test or homework) be regraded, I reserve the right to regrade the entire submission rather than just a single problem.

20. **Grading Scale:** Grades (and the corresponding grade points) will be assigned according to the Registrar's official policies. Grades will be curved.

   Undergraduate students, in order to graduate, must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement.

   Graduate students, in order to graduate, must have an overall GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement.

   For more information on grades and grading policies, please visit: `https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx`

21. **Make-up Exam Policy:** If an exam must be missed, the student must see the instructor and make arrangements **in advance** unless an emergency makes this impossible. Approval for make-up exams is much more likely if the student is willing to take the exam early. Any other exam absence will result in the student receiving a zero for that grade. Students who miss pop quizzes or online quizzes will receive zeros for that grade.

22. **Honesty Policy:** All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action.

This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others.

Additional requirements and information:

Honor statements on tests must be signed in order to receive any credit for that test.

I understand that many of you will have access to at least some of the homework solutions. Time constraints prohibit me from developing completely new sets of homework problems each semester. Therefore, I can only tell you that homework problems exist for your benefit. It is dishonest to turn in work that is not your own. In creating your homework solution, you should not use the homework solution that I created in a previous year or someone else's homework solution. If I suspect that too many people are turning in work that is not their own, then I will completely remove homework from the course grade.

Collaboration on homework is permitted **and encouraged** unless explicitly prohibited, provided that:

(a) Collaboration is restricted to students currently in this course.

(b) Collaboration must be a shared effort.

(c) Each student must write up his/her homework independently.

(d) On problems involving MATLAB programs, each student should write their own program. Students may discuss the implementations of the program, but students should not work as a group in writing the programs.

 I have a zero-tolerance policy for cheating in this class.

If you talk to anyone other than me during an exam, I will give you a zero. If you plagiarize (copy someone else's words) or otherwise copy someone else's work, I will give you a failing grade for the class. Furthermore, I will be forced to bring academic dishonesty charges against anyone who violates the Honor Code.

23. **Accommodation for Students with Disabilities:** Students requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

24. **UF Counseling Services:** Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- U Matter, We Care: `http://www.umatter.ufl.edu`, 294-CARE (2273), umatter@ufl.edu, @UMATTERWECARE
- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

25. **Software Use:** All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.