ENTS 759B Wireless OFDM Systems - Spring 2021 Syllabus

Goals: Students will learn the main concepts and technologies used in the design of current wireless OFDM systems, focusing on the physical layer. Students will see topics including OFDM modulation/demodulation, role of the cyclic prefix, pilot symbols and preambles, transmit/receive filtering, RF impairments and their impact on performance, channel estimation, timing and synchronization. Then, students will learn about the 4G LTE standard’s and the Wi-Fi 6 standard’s physical layers, respectively. As a part of the course work, students will implement an OFDM-based transceiver using Ettus B210 software defined radios. Pre-requisite(s): passed ENTS622 or passed the ENTS622 Placement Exam

Learning Environment:
• Section 0101 Lectures will be held: Tuesdays 2:00pm – 4:45pm online, through Zoom in Canvas
• Section 0101 Labs will be held: Mondays 12:30pm – 2:30pm in-person in AVW 1362  
  (first floor) of A.V. Williams Bldg, 8223 Paint Branch Dr, College Park, MD 20740

Who is your instructor?
Name: Alejandra Mercado  (email address: mercado@umd.edu, web page)
Office Location: AV Williams Building 1365 (Office Hours will be held virtually through Webex in Canvas)
Office Hours:
• Mondays, 11AM-12PM: these are “open” office hours through an open Zoom session; just open the Zoom link in Canvas to say, “hi” or chat with colleagues and the instructor, or to see a friendly face 😊
• Tuesdays, 11AM-12PM: these are “private” office hours, so you may speak privately with your instructor and discuss grades or other private matters. These office hours will be through Webex, which can provide privacy and security. To sign-up for these, you must always set up appointments online, through this link; once you’ve signed up, the instructor will give send you a link to the Webex meeting.

Program link: https://telecom.umd.edu/

Course Web Site: https://elms.umd.edu/

Logging in to the Course for Announcements, Zoom lectures, Webex or Zoom Office Hours, documents, etc.:
Go to http://elms.umd.edu. Type in your Maryland Directory ID in the box labeled Username.
Enter your Directory password in the Password box

Texts: No required textbook

Assessments to Measure Progress in the Course:

<table>
<thead>
<tr>
<th>Default Grading Vector:</th>
<th>Final Course Grading will be determined using the following scale based on the overall average score:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation (Zoom polls): 5%</td>
<td>• Threshold for A-, A, A+ : weighted course grade ≥90%</td>
</tr>
<tr>
<td>Midterm exam: 30%</td>
<td>• Threshold for B-, B, B+ : weighted course grade ≥80%</td>
</tr>
<tr>
<td>Software Defined Radio Project:</td>
<td>• Threshold for C-, C, C+ : weighted course grade ≥70%</td>
</tr>
<tr>
<td>Project Milestone 1: 9%</td>
<td>• Threshold for D-, D, D+ : weighted course grade ≥60%</td>
</tr>
<tr>
<td>Project Milestone 2: 9%</td>
<td>• Threshold for F : weighted course grade &lt; 60%</td>
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<tr>
<td>Project Deliverable: 15%</td>
<td></td>
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<tr>
<td>Final Exam: 32%</td>
<td></td>
</tr>
<tr>
<td>Total: 100%</td>
<td></td>
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</tbody>
</table>

What does a letter grade mean? For the UM explanation of Quality Points, click here.

±A  denotes excellent mastery of the subject and outstanding scholarship.
±B  denotes good mastery of the subject and good scholarship.
±C  denotes acceptable mastery of the subject and the usual achievement expected.
±D  denotes borderline understanding of the subject and marginal performance.
F   denotes unsatisfactory performance.
XF  denotes failure due to academic dishonesty.

Masters in Telecommunications Program, ENTS 759B: Wireless OFDM Systems
I often get this question, "How much do I need on the final exam to get an A?"

There are students who will not have performed well on the midterm and others will not have performed well on the final exam, so what I'm doing is the following: by default the grading weights are what is shown in the table above:

\[ w_{\text{default}} = (4\%, 30\%, 9\%, 9\%, 15\%, 33\%) \]

At the end of the semester, I will create about five other experimental weights: \( w_2, w_3, w_4, \text{ etc.} \)

For each individual student, I will choose the weight vector, \( w_k \), that yields the highest overall course grade for that individual person. The best vector will not be the same for all students (because maybe you did poorly on the midterm, but your friend did poorly on the final); so each student will get the best vector for his or her highest grade from that set of four or five vectors. The vectors are created with the help of histograms for each assessment.

Therefore, predicting "what grade do you need to get an A" is impossible at this point, because I'm missing too much information.

Do the best you can. Keep in mind that I do NOT want any quota of As, Bs or Cs. I will be very happy if every single one of you earns an A.

**Tentative Course Schedule**

The instructor reserves the right to make schedule changes based on the needs of the students, possible campus closures, and class progress.

<table>
<thead>
<tr>
<th>Lecture Number</th>
<th>Date</th>
<th>Lecture Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 26</td>
<td>Overview of syllabus and Canvas. Overview of basics: Signals, spectral analysis, communications systems</td>
</tr>
<tr>
<td>2</td>
<td>Feb 2</td>
<td>Overview of channel noise and fading. Overview of single-carrier communications. Introduction to OFDM. Project Overview</td>
</tr>
<tr>
<td>3</td>
<td>Feb 9</td>
<td>OFDM system model. Transmit/receive filtering, RF impairments and their impact on performance.</td>
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<tr>
<td>4</td>
<td>Feb 16</td>
<td>OFDM reference signals and receiver design issues: channel estimation, timing and synchronization</td>
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<tr>
<td>5</td>
<td>Feb 23</td>
<td>OFDM multi-antenna MIMO and beamforming transmission techniques.</td>
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<tr>
<td>6</td>
<td>Mar 2</td>
<td>Introduction to LTE: PHY overview, system architecture.</td>
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<td>-</td>
<td>Mar 8</td>
<td>Midterm in the AVW 1362 lab</td>
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<tr>
<td>7</td>
<td>Mar 9</td>
<td>Project milestones 1 &amp; LTE Scheduling and link control.</td>
</tr>
<tr>
<td>-</td>
<td>Mar 15-19</td>
<td>Spring Break – no lectures, no labs</td>
</tr>
<tr>
<td>8</td>
<td>Mar 23</td>
<td>LTE downlink transmission.</td>
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<tr>
<td>9</td>
<td>March 30</td>
<td>LTE downlink transmission.</td>
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<tr>
<td>10</td>
<td>Apr 6</td>
<td>LTE uplink transmission.</td>
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<tr>
<td>11</td>
<td>Apr 13</td>
<td>LTE access and transmission procedures</td>
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<tr>
<td>12</td>
<td>Apr 20</td>
<td>Project milestones 2 &amp; flexible bandwidth operation</td>
</tr>
<tr>
<td>13</td>
<td>April 27</td>
<td>802.11ax Trigger-based random access, mod/coding, coloring</td>
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<tr>
<td>14</td>
<td>May 4</td>
<td>802.11ax MU MIMO</td>
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<tr>
<td>-</td>
<td>May 7</td>
<td>Project due (file upload to Canvas)</td>
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<tr>
<td>15</td>
<td>May 11</td>
<td>802.11ax symbol duration, guard interval &amp; delay spread</td>
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<tr>
<td>-</td>
<td>May 17 (tentative)</td>
<td>Final exam – in the AVW 1362 lab</td>
</tr>
</tbody>
</table>
A. Requirements

Students are expected to be on time, attend all class meetings, and complete all assignments and all assessments of their knowledge and understanding of the class material. Students are required to make suitable accommodations to work with their team-members and with their classmates to complete the class project, and all students are required to contribute a fair and proportional amount of time and effort towards the software defined radio project.

B. Assignments

Any assignment that is turned in should be complete, and represent the student’s individual and original work. Late assignments will not be accepted, as this would place an unfair burden on students who hand in their work in a timely manner.

C. Make-up Policy

In the case of an excused absence (such as a disabling medical emergency with a letter from a physician on official letterhead, or a death in the immediate family with proper documentation), the instructor will redefine the grading distribution in accordance with what assessment was lost. Unexcused absences will result in a grade of zero for the missed assessment.

Excused Absence: If you miss an assessment (test or project), contact me as soon as possible.

Religious Observance: The student should inform the instructor at the beginning of the semester about any absences due to religious observances. We will make appropriate arrangements for the missed assessment. This must be NO LATER than the second week of classes.

D. Academic Honesty

The maintenance of the highest standards of intellectual honesty is the concern of every student and faculty member at the University of Maryland. Plagiarism, which is defined as appropriating or closely imitating another person's work or ideas and representing them as one's own original work, is strictly prohibited. Use of smart phones, tablets, or other electronic devices during a test is not allowed.

Academic Dishonesty or Misconduct can occur in many ways. Some examples are:

a) Plagiarizing from written, video, or Internet resources
b) Forgery
c) Submitting materials that are not the student's own work, such as Matlab code or GnuRadio scripts
d) Taking examinations in the place of another student, including assessment tests
e) Assisting others in committing academic dishonesty
f) Copying from another student during an examination or on an assignment.

Failure to abide by the rules of Academic Integrity (which, in addition to the described above is detailed in https://policies.umd.edu/policy/d3c4519f-99f1-42e9-a224-300e746a7a13/) will result, at the very least, in a grade of XF: the grade appears on the student's transcript with the notation "Failure due to academic dishonesty." As well as further disciplinary actions. Learn more at the Office of Student Conduct.

D.1. Lectures are UM Intellectual Property

In accordance with ENTS and UM policy, persons who publicly distribute or display or help others publicly distribute or display copies or modified copies of an instructor's Course Materials will be considered in violation of the University Code of Student Conduct.

Lecture materials may not be video-taped, audio-taped, photographed, or otherwise reproduced for distribution without the explicit knowledge and permission of the course instructor and written permission of the Director of the Master’s in Telecommunications Program.

E. Support Services

Disability Support Services (DSS): Any student who may need an accommodation due to a disability should contact DSS offices at 0106 Shoemaker Building (301.314.7682). Their website is https://www.counseling.umd.edu/ads/
F. Cancellation of Classes or Labs
You may check the UMCP web page at https://umd.edu/weather

Check the canvas course site frequently and always before coming to campus for labs or lectures, as the instructor will post announcements there about class cancellations or other course-related matters.

G. Academic Calendar
For the current UMD academic calendar, please click here.

H. Use of Lab facilities and computers
All students are required to comply with University of Maryland Code of Student Conduct (in particular part 10, “Prohibited Conduct” with special attention to part 10 (c) “Property Offenses,” click here). Before being allowed to use the lab facilities, each student will be required to sign the TERMS FOR PERMISSION TO USE THE LAB in AVW 1362 form, which is available through Canvas.

In addition, with the computers in the lab, as well as all computers on campus, students are required to comply with the University of Maryland Policy on Acceptable Use of Information Technology Resources (click here for those policies).

H.1. Information Technology and Privacy Policy
In reference to the collection of personal information on official university websites: Official university websites use the domain names "umd.edu" and "maryland.edu" and are controlled, operated, and maintained by university personnel in connection with university business. If you are asked to provide personal information on an official university website, university policy in this respect is detailed here.

Network with your Colleagues:
Students learn best from each other when studying together. Also, class contacts are useful in the event you miss a class. In that vein, I encourage you to meet your neighbors, and get their contact information.

Name: __________________________ Name: __________________________ Name: __________________________
Email: __________________________ Email: __________________________ Email: __________________________
Phone: __________________________ Phone: __________________________ Phone: __________________________

Contact the instructor: The best ways to reach me is during my office hours or via email. Please use your UM email address; due to privacy issues I may not read mail from personal email addresses.

VETERANS
If you are a veteran or on active or reserve status and you are interested in information regarding opportunities, programs and/or services, please visit the University of Maryland Veterans Program Office website at http://www.veterans.umd.edu/