**EE 341: Signals and Systems (Fall 2018)**

**Catalog Description:** (3 credits) Discrete and continuous-time signals, LTI systems, convolution, sampling, Fourier transform, filtering, amplitude modulation, probability applications. (*Pre-req. EE 321, Co-req. Math 360*)

**Instructor:** T. Fischer  
e-mail: thomas_fischer@wsu.edu  
Tel: 509 335 4960  
Office Hours: MWF 10:15-11:15 a.m., MW 2:15-3:15 pm, or by appointment (EME 404)  
Lecture Hours: MWF 1:10 –2:00 p.m. (Sloan 150)  
Best way to reach me outside office hours: Via e-mail.

**Teaching Assistant:** TBA

**Course Webpage:** [http://eecs.wsu.edu/~fischer](http://eecs.wsu.edu/~fischer)

This will serve as a repository for:
- Syllabus and other course handouts
- Homework, homework solutions
- Links to online resources

**Textbook:**

**Text companion website:** [http://www.ee.washington.edu/class/SST_textbook/textbook.html](http://www.ee.washington.edu/class/SST_textbook/textbook.html)

- The text website contains many useful resources:
  - A short introduction to Matlab
  - Links to online demos for some important concepts
  - Errata
  - Interesting links to other signals & systems resources on the web

**References:**

**Course Outline:**
This is an introductory course on signals and systems - required course for all BSEE students. This course deals with discrete and continuous time signals, linear time-invariant systems, convolution, sampling, Fourier transforms, filtering, amplitude modulation, information and entropy. We will cover most of chapters 1-6, 9, 10, 12 in the text.

**Prerequisites:**
- **By course:** EE 321, Math 360 (Co-req.)
- **By Topic:** Linear algebra, Laplace transforms, Linear circuits, Exposure to Matlab, Fourier series. A good understanding of Calculus (typically covered in the first two Calculus courses) is essential. A basic understanding of probability (by the second half of the semester) is expected.

**Student Learning Outcomes and Assessment**

Lectures present the theory and application of the course topics. Out-of-class work includes reading from the textbook and provided notes and homework exercises. Students should expect to invest at least 2 hours of work outside of class for every hour of lecture.

**Specific goals for the course and means of assessment**

a. *specific outcomes of instruction (ABET outcomes covered are in parenthesis)*

At the end of this course, students must be able to:
• Analyze linear time-invariant systems in time-domain (continuous- and discrete-time) (1). Assessed through homework and exams.
• Analyze linear time-invariant systems in frequency-domain (continuous-time) (1). Assessed through homework and exams.
• Compute the spectrum of a sampled signal and its reconstruction from the samples, based on the spectrum of a continuous-time signal (1). Assessed through homework and exams.
• Design frequency-selective analog filters (2). Assessed through homework and exams.
• Apply frequency-domain techniques to analyze different modulation schemes in communication systems (1, 2). Assessed through homework and exams.
• Apply probability theory to simple problems in communication systems (1, 2). Assessed through homework and exams.

b. explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Brief list of topics to be covered and approximate number of lecture hours

- Elementary signals and examples of systems, system properties, 6hrs
- Linear time-invariant (LTI) systems: impulse response, convolution, properties of convolution and its application to LTI systems, 6hrs
- Fourier series (FS) and Fourier transform (FT), 6hrs
- Application of FS and FT to LTI systems, Filtering, Bandwidth, 3hrs
- Sampling analog signals and their reconstruction from samples, 3hrs
- Filter design, 3hrs
- Application to communication systems — Amplitude modulation schemes, demodulation, 3hrs
- Discrete time Fourier transform (DTFT), 3hrs
- Probability Applications — Binary pulse amplitude modulation, Information Theory and Huffman Coding, 8hrs
- Exams and review, 4hrs

Grading:
The grades in this course will be based on:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>16%</td>
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<tr>
<td>Midterm tests: (9/26, 10/24, 11/28)*</td>
<td>18% each</td>
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<tr>
<td>Final exam: (Wed., Dec., 12, 8:00 a.m. to 10:00 a.m.)</td>
<td>30%</td>
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Final numerical averages will be rounded to the nearest integer value, and grades assigned as follows:

- 100 – 93: A
- 92 – 90: A-
- 89 – 87: B+
- 86 – 83: B
- 82 – 80: B-
- 79 – 77: C+
- 76 – 73: C
- 72 – 70: C-
- 69 – 60: D
- <=59: F

General Course Policy:
1. **Homework:** Homework will be assigned roughly every one to two weeks and normally due one week after it is assigned. The lowest two homework scores for each student will be dropped before computing the final weighted score. This is intended to compensate for occasional conflicts with other commitments.
2. **Submission of Homework:** All homework is to be submitted (as a “hard copy” – no electronic submissions) on the day it is due. Except in very unusual circumstances, late submissions will **not** be accepted.

* Dates are tentative and will be finalized 1-2 weeks before the actual date.
3. **Midterm Exams**: There will be three midterm exams in all. You will be allowed two 8.5” by 11” single-sided study sheets for each midterm exam. It is your responsibility to include all relevant formulae, tables, etc. in this sheet. Besides the problems, I will not be providing anything else during the exam.

4. **Office hours**: If you cannot see me during regular office hours (or even otherwise), you are encouraged to send me course messages via e-mail and/or setup another mutually convenient meeting time. I will try to answer queries as soon as possible (within a few hours in most cases, if I am in town).

5. **Academic honesty**: I encourage discussion of class material and, to a limited extent, homework problems among students. However, each student must turn in original work. No copying will be accepted. It is not permitted, under any circumstances, to consult or plagiarize past homework solutions. Cheating during an exam is considered to be a serious violation of ethical integrity. Any material you turn in for a grade must be your own work. Cases of academic dishonesty shall be dealt with in accordance with Academic Integrity Policy for the School of Electrical Engineering and Computer Science found at [http://www.eecs.wsu.edu/~schneidj/Misc/academic-integrity.html](http://www.eecs.wsu.edu/~schneidj/Misc/academic-integrity.html). Academic sanctions will range from receiving no credit for the assignment to failing the course and decertification from the degree program. If you are aware of any incidents of cheating by fellow students, please bring it to my attention, as soon as possible.

6. **Attendance**: I do not intend to impose regular lecture attendance. However, I don’t expect anyone to be habitually absent. If you miss a class, it is your responsibility to make-up the material covered in class (see me before or after the class or ask one of your classmates). You are responsible for all announcements made during that class.

7. **Make-up Exams**: Absence from an exam will be excused only for very serious medical or personal emergencies. Please let me know as soon as possible, preferably before the exam, if you would be unable to take an exam. In such cases, a make-up test will be given, at a time to be arranged.

8. **Computer accounts**: All students registered for this course are encouraged to get an account on the EECS computer systems. Contact the systems staff about this (let me know if you still have difficulties).

9. **Holidays**: There will be no class on the following days: Labor Day --- Mon., Sept. 3, 2018; Veteran’s Day --- Mon., Nov. 12, 2018; Thanksgiving Break --- Nov. 19-23, 2018.

10. We will use Matlab in many HW exercises. Students who wish to have MATLAB on their own personal computers can purchase MATLAB & Simulink Student Version for around $99 from either of the following: Campus book store or [www.mathworks.com/store](http://www.mathworks.com/store). However, note the recent announcement of Matlab availability at WSU. An alternative to Matlab is Octave, an open-source resource that can be downloaded from the gnu.org website. Many of the Matlab functions have Octave equivalents. (However, some modifications may be necessary. Caveat emptor.)

**WSU Reasonable Accommodation Statement**

“Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center at Pullman or WSU Online: 509-335-3417, Washington Building 217; [http://accesscenter.wsu.edu](http://accesscenter.wsu.edu), [Access.Center@wsu.edu](mailto:Access.Center@wsu.edu) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist on your home campus.”

**WSU Academic Integrity Statement**

“Academic integrity is the cornerstone of higher education. As such, all members of the university community share responsibility for maintaining and promoting the principles of integrity in all activities, including academic integrity and honest scholarship. Academic integrity will be strongly enforced in this course. Students who violate WSU’s Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(3) and -404) will receive a grade of F for the course, will not have the option to withdraw from the course pending an appeal, and will be reported to the Office of Student Conduct.

Cheating includes, but is not limited to, plagiarism and unauthorized collaboration as defined in the Standards of Conduct for Students, WAC 504-26-010(3). You need to read and understand all of the definitions of cheating: [http://app.leg.wa.gov/WAC/default.aspx?cite=504-26-010](http://app.leg.wa.gov/WAC/default.aspx?cite=504-26-010). If you have any questions about what is and is not allowed in this course, you should ask course instructors before proceeding.

If you wish to appeal a faculty member's decision relating to academic integrity, please use the form available at [conduct.wsu.edu](http://conduct.wsu.edu).”
Safety and Emergency Notification

“Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the “Alert, Assess, Act,” protocol for all types of emergencies and the “Run, Hide, Fight” response for an active shooter incident. Remain ALERT (through direct observation or emergency notification), ASSESS your specific situation, and ACT in the most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety, and related topics, please view the FBI’s Run, Hide, Fight video and visit the WSU safety portal.”

Week-To-Week Course Outline

<table>
<thead>
<tr>
<th>Week no.</th>
<th>Dates</th>
<th>Topic (sections from text)</th>
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<tbody>
<tr>
<td>1</td>
<td>Aug 20-24</td>
<td>Chapter 1&lt;br&gt;Chapter 2: 2.1, 2.2, 2.3&lt;br&gt;Chapter 9: 9.1, 9.2, 9.3</td>
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<td>2</td>
<td>Aug 27-31</td>
<td>Chapter 2: 2.4, 2.5, 2.6 (browse), 2.7&lt;br&gt;Chapter 9: 9.4, 9.5 (browse), 9.6</td>
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<tr>
<td>3</td>
<td>Sept 5-7</td>
<td>No class Sept 3 (Labor Day)&lt;br&gt;Chapter 3: 3.1, 3.2&lt;br&gt;Chapter 10: 10.1, 10.2</td>
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<td>4</td>
<td>Sept 10-14</td>
<td>Chapter 3: 3.1, 3.2, 3.3, 3.4&lt;br&gt;Chapter 10: 10.3</td>
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<td>5</td>
<td>Sept 17-21</td>
<td>Chapter 3: 3.5, 3.8, 3.6 (browse), 3.7 (browse)&lt;br&gt;Chapter 10: 10.4, 10.5 10.5 (browse), 10.7 (browse)&lt;br&gt;Chapter 4: 4.1, 4.2, 4.3</td>
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<tr>
<td>6</td>
<td>Sept 24-28</td>
<td>Exam 1 on Wed, Sept 26&lt;br&gt;Chapter 4: 4.4, (browse through 4.5 and 4.6)&lt;br&gt;Chapter 5: 5.1, 5.2</td>
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<tr>
<td>7</td>
<td>Oct 1-5</td>
<td>Chapter 4: 4.5&lt;br&gt;Chapter 5: 5.2, 5.3, 5.4</td>
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<td>8</td>
<td>Oct 8-12</td>
<td>Chapter 5: 5.5, 5.6&lt;br&gt;Chapter 6: 6.1, 6.2 (for now, disregard discussion about design of filters; this will be covered later in more detail), 6.3</td>
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<td>9</td>
<td>Oct 15-19</td>
<td>Chapter 6: 6.3, 6.4, 6.5 (supplemented with class notes)</td>
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<tr>
<td>10</td>
<td>Oct 22-26</td>
<td>Exam 2 on Wed, Oct 24&lt;br&gt;Chapter 6: 6.4, 6.5&lt;br&gt;Filter design: Notes provided</td>
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<tr>
<td>11</td>
<td>Oct 29-Nov2</td>
<td>Filter design&lt;br&gt;Chapter 6: 6.6</td>
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<td>12</td>
<td>Nov 5-9</td>
<td>Chapter 6: 6.6&lt;br&gt;Information Theory &amp; Huffman Coding (notes provided)</td>
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<td>13</td>
<td>Nov 14-16</td>
<td>No class Nov 12 (Veteran’s Day)&lt;br&gt;Information Theory &amp; Huffman Coding (notes provided)&lt;br&gt;Pulse Amplitude Modulation (notes provided)</td>
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<td>Nov 19-23</td>
<td>Thanksgiving Break: no class</td>
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<tr>
<td>14</td>
<td>Nov 26-30</td>
<td>Exam 3 on Wed, Nov 28&lt;br&gt;Pulse Amplitude Modulation&lt;br&gt;Chapter 12: 12.1 (supplemented with class notes)</td>
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<td>15</td>
<td>Dec 3-7</td>
<td>Chapter 12: 12.1&lt;br&gt;Course Review</td>
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Final Exam on Mon, Dec 10, 3:10-5:10 pm