Course Syllabus
CSD3317 Human Rhythms
Western University, January-April, 2019

Instructor: David Purcell, Ph.D., Associate Professor
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email: purcelld@nca.uwo.ca
Office hour: Meetings welcome by appointment.
Lectures: 9:30-10:20am Wednesdays and Fridays; Elborn College room 1548
Laboratory: 10:30-11:20am; Session #1 Wednesdays, Session #2 Fridays; Elborn College room 1555
(Students need only attend one laboratory session.)

1. Overview and Purpose of Course

The human body produces many rhythms from the brain (the electroencephalogram or EEG), heart (electrocardiogram or ECG), muscles (electromyogram or EMG), ears (otoacoustic emissions), and even the voice. These 'signals' can tell us about the body's function including clinically useful information used in the diagnosis of disease. Learning to work with physiological signals is a modern skill that is useful in diverse areas such as neuroscience, psychology, medical sciences, nursing, health and rehabilitation sciences, kinesiology, audiology, speech language pathology, and other sciences. In brief, this course introduces the basics of working with physiological signals measured from the human body.

You will learn how to view, process, and analyze example signals such as the heart's electrical activity, brain activity, and even the human voice. Topics about signal processing will include introductions to how we represent signals, how to improve the quality of a measurement by filtering and removing artifacts, how to further remove noise with averaging (essentially improving the “signal-to-noise ratio”), as well as working with signals using both time and frequency representations. To obtain hands-on skills working with signals, students will learn some MathWorks MATLAB programing language to complete signal analysis exercises with instructors in the laboratory and subsequent related assignments.

Lectures will include a mix of familiar PowerPoint type slides as well as working through ideas using MATLAB. Material introduced in lecture is followed by weekly exercises in a laboratory session so that students can obtain direct experience with their new knowledge and develop programming skills with the help of instructors.

Course material will be delivered at a level appropriate for third year undergraduate students and I will not assume much mathematical knowledge or any programming experience. It is my purpose for the course that students without related backgrounds will learn the basics of signal processing and will take away basic programming skills that will be useful in other courses and future work. Knowing how to program can give an individual confidence and ability to take on interesting challenges in the future. Students with a background in these areas may find the course slower than their preference, but there may still be novel elements that are of interest.

2. Installing MATLAB
Western has a site license for MATLAB so you can choose to install it on your own computer! Read about that here:
http://www.uwo.ca/its/sitelicense/matlab/

And how to install on your machine:
https://wts.uwo.ca/sitelicense/matlab/index.html
3. Course Textbook

a) There are two aspects to this course: signal processing and learning programming in MATLAB. I haven't been able to find a signal processing text that is at the right level or scope for the course. Therefore, I will provide what you need to learn about signal processing in lectures and some partial readings. The good news is that there are many appropriate texts that can help you to learn to program in MATLAB.

Mastering MATLAB by Duane Hanselman, Bruce Littlefield
2012 edition ISBN 9780136013303 (alk. paper); 0136013309 (alk. paper)

This textbook will be available at the bookstore and a much older version is available at the Taylor library. Unfortunately, it is not an inexpensive reference book.

An alternative text available from other vendors is less expensive, but it is less thorough and in some ways a more difficult read. It does however contain the basics if you don't worry so much about the exercises.

Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers by Rudra Pratap

Another alternative text is a little more advanced but would be an interesting reference for the future as well.

MATLAB for Brain and Cognitive Scientists by Mike X Cohen
2017 ISBN: 9780262035828

Finally, the Taylor library has a nice introductory book with examples specific to sound and speech.

MATLAB primer for speech-language pathology and audiology by Boutsen, Dvorak

b) Additionally, there are many free online resources to help learn the programming language MATLAB. An example is the MATLAB Onramp tutorial (the first of the "Course Offerings" at the page below). You will need to create an account:  https://matlabacademy.mathworks.com/

There is also a set of learning videos on YouTube that you might like: https://www.youtube.com/watch?v=T_ekAD7U-wU

c) There is a free signal processing textbook available online, but it does not present material at the right level for our course:

http://www.dspproject.com/pdfbook.htm
The Scientist and Engineer's Guide to Digital Signal Processing by Steven W. Smith
1997 ISBN: 0-9660176-3-3

4. Evaluation

a) There will be four practical assignments over the course of the term that require use of your newly developed MATLAB programming skills to perform some signal processing and analyses. These assignments will follow classroom material that provides the necessary background information. You will
need to write a “pseudocode” plan for your program in English and “comment” most lines of your MATLAB code using English descriptions so that it is straightforward for a reader to follow your approach. You may work collaboratively to learn the concepts, but the work you turn in must be your own. Late assignments will be accepted; however you will lose ½ point (i.e. 10% of the total mark) per day without a valid excuse (e.g. doctor’s note).

Each assignment is worth 5% and the four together will compose 20% of your course grade. The schedule for assignments will be given at the start of the winter term.

b) Participation in labs is essential. Concepts covered in the lectures will be reviewed and practical examples worked through. These examples will be relevant to the assignments and to the examinations. Participation in laboratory sessions is worth 5% of your course grade. Participation means attending and performing the planned exercises. The 5% will be evenly distributed over participation at the 12 laboratory sessions.

c) There will be a one-hour “example test” scheduled during class time in early February. The purpose of this test is to give you an introduction to what the midterm and final will be like. This small test is worth 5% of your course grade.

d) There will be a two-hour midterm test scheduled outside of class time towards the end of February. The midterm test will be worth 25% of your course grade.

e) There will be a final examination scheduled during the regular Western examination period in April. Please do not make travel plans until the central scheduling people have provided us with an examination date and location. The final examination is comprehensive and may include material from any time during the course. That said, later course material is built upon earlier concepts, so those earlier concepts will have been reinforced as later material is learned. The examination will draw upon what you have learned in the classroom, laboratory exercises, and assignments. The final examination is worth 45% of your course grade.

5. More details about how the course will run

a) Questions?
Ask during class. Collaborate with your classmates. See me after class. Make an appointment to see me. I prefer to answer questions in person because I find it is less error prone to refer to figures and draw things out. If you need to ask a straightforward question by email, I will respond during regular business hours. If you find yourself writing a long complicated email… just ask to meet me because that is what I will ask of you! If I think that your question may be relevant for others in the class, I will ask your permission to post an anonymized version and its response on OWL after our discussion. If you do e-mail, please use your Western email and use an informative subject line that includes the course number (CSD3317). All faculty members receive a tremendous amount of email.

b) Students with Special Needs: Students with special needs should talk to me confidentially so that informal accommodations (e.g. seating) can be made. Requests for formal academic accommodations must be made through Services for Students with Disabilities (http://www.sdc.uwo.ca/ssd/).

c) Electronic devices: Notebook and tablet computer use in class for note-taking and class-related activities is permitted but general web browsing and social media can be distracting to other students and are therefore not permitted. Cell/smart-phone use and texting are not permitted. Non-programmable calculators are permitted in exams.

d) Classroom Atmosphere and Teaching Style:
I tend to ask a lot of questions in class, and, since we do not have a large group, I encourage you to do the same. I ask questions to facilitate the putting-together of concepts and information, to emphasize and
reiterate important points, and to gauge whether explanations have been effective. I do not do it to put people “on the spot”, so do not be afraid to give an “unexpected” answer – it may help the group to learn. If you dread after-question silences, speak up! It is my intention that our classroom be friendly and collaborative so that everyone has a good learning experience and there is no hesitation asking questions. My teaching approach emphasizes “learning by doing”, which I feel has helped many of my students become comfortable with new ways of thinking and to excel at the “doing” part. You are expected to come prepared and to participate actively in the class and labs.

e) Health and Wellness
Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help. As part of a successful student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western’s Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page http://www.music.uwo.ca/ , and our own McIntosh Gallery http://www.mcintoshgallery.ca/ . Information regarding health- and wellness-related services available to students may be found at http://www.health.uwo.ca/ . Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty advisors, their program director, or other relevant administrators in their unit. Campus mental health resources may be found at http://www.health.uwo.ca/mental_health/resources.html .

f) Academic Offenses
Students must do their own work. It is encouraged to learn together, but each individual must understand the material and work through problems themselves. If written answers use ideas, code, or short passages from other authors, they must be properly referenced. Plagiarism from fellow students or other sources is cheating and is a major offense. Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

All code may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All materials submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of material subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com )

g) OWL: The class web page will be used to make lecture materials available. Assignments will be distributed and submitted through OWL. Announcements will be made on OWL, and answers to questions of interest to the class will be posted.

h) Changes to the Timetable: There will almost certainly be variations to the topic schedule provided during the first few classes.

i) Policy on Accommodation for Illness: Please see Western’s policy at the URL below. http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf

j) Some other URLs that may be useful:
k) Expected Schedule for Classes and Labs will be provided at the start of term.

L) Planned Topics (some variation will occur!)

<table>
<thead>
<tr>
<th>General Topic Order (Some topics make multiple appearances throughout)</th>
<th>Signal Processing Topic</th>
<th>Supporting MATLAB Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Continuous and Sampled Signals</td>
<td>Variables, vectors, and plotting</td>
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<tr>
<td>2</td>
<td>Sampling Rate</td>
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<tr>
<td>3</td>
<td>Time and Frequency Representations</td>
<td>Using and Plotting Fourier Transforms</td>
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<tr>
<td>4</td>
<td>Choosing Sample Rate (avoiding Aliasing)</td>
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<td>5</td>
<td>Stages of Signal Acquisition</td>
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<tr>
<td>6</td>
<td>Quantization and Dynamic Range (including the Decibel scale)</td>
<td>Decibel Calculation</td>
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<tr>
<td>7</td>
<td>DC Offsets and Clipping</td>
<td>Calculating the Mean</td>
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<tr>
<td>8</td>
<td>Linear Systems and Transfer Functions</td>
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<tr>
<td>9</td>
<td>Analysis Windows</td>
<td>Pseudo Code, For Loops and Functions, Debugging Tools</td>
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<tr>
<td>10</td>
<td>More on Frequency Analysis: Limitations, Window Shapes, Special Frequencies of Interest, and Phase Spectra</td>
<td>Window and Frequency Response Tools and Plots</td>
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<td>11</td>
<td>Filter Design</td>
<td>Filter Functions</td>
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<tr>
<td>12</td>
<td>Signal to Noise Ratio in Time and Frequency Representations</td>
<td>More practice with For Loops and Functions</td>
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<td>13</td>
<td>Artifact Rejection</td>
<td>Histogram Plots</td>
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<td>14</td>
<td>Synchronous Averaging</td>
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<td>15</td>
<td>Estimation of Signal Parameters</td>
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<tr>
<td>16</td>
<td>Signal Detection in Noise</td>
<td>Some statistical functions</td>
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</table>

Thanks for your interest in CSD3317! It is my plan that everyone takes away some new knowledge and useful skills!