42-699: Introduction to Biomedical Signal Processing

The instructor for this course is Jelena Kovačević.

Basic course information

The course will meet for one lecture each week.
- Course date and times: Tuesdays, 6:00pm – 8:50pm, WEH 5403
- Instructor’s office hours: By appointment
- Contacting the Instructor: The best way to contact me is by email (jelenak at cmu dot edu). Putting "42-699" in the Subject line guarantees a faster response from me.
- TA: Mike McCann (mtmccann at cmu dot edu)
- TA’s office hours: TBD, or by appointment

All course material will be posted at the course site. Lecture topics can change without notice depending on the students enrolled and their backgrounds.

Course goals

This course is geared towards graduate students who have not been exposed to signal processing before. The aim is to introduce basic signal processing tools for analysis and mining of biomedical signals. These will include an introduction to digital sequences (1D and multiD), systems, and analysis tools (Fourier and wavelet). We will cover some basic tasks used in various biomedical signal-processing applications, with particular emphasis on biomedical image processing. As part of the course, students will be expected to complete an independent project. The course is roughly divided in two parts:
- The first part introduces the necessary mathematical tools with a great emphasis on intuitive understanding of how they operate on real-life signals while keeping the necessary mathematical rigor.
- The second part is project-based, where, through your own biomedical-imaging project, you will learn how to choose a research area, formulate a problem, research previous work, propose your own solutions, carry out experiments and interpret results. The focus is on training you to become a researcher. To that end, you will write a paper in a typical conference format and present your project at the end of the class.

Through this independent project, you will learn to recognize techniques covered in the course, evaluate their usefulness in the real world and compare them to other techniques available. You will also develop your own algorithm to solve a practical problem.

My stress in this course is on the process of learning. If you strive to understand and apply the concepts you learned in class, you will be successful in it. Asking questions and doing is the best way to learn. There are no stupid questions. You are not in class to impress me but to learn and develop one step closer to being an independent researcher. Asking a lot and early is the way to go. Do not wait for five minutes before homework due time/midterm/project presentation to ask a question because I will not have sufficient time to go into details with you.
I will continuously assess how the course is going by using feedback from you. I will give you an anonymous 5-minute questionnaire at the end of each class where I will ask you to rate and give comments on a variety of topics to do with the course: from my preparation and delivery, to the level of difficulty of homeworks and anything else you wish to add. I will use that to answer your concerns and to improve your learning experience. I will not see these forms; someone else will type them for me.

Course materials
The required textbook is the instructor’s textbook that is about to be published. The instructor will make it available to students on Blackboard. The free version (that does not contain hyperlinks nor exercises is Foundations of Signal Processing.

Grading policies
Class participation: Active class participation is very important. It will count as much as homework towards the final grade. After each class, I will note your level of participation. Active participation means getting to class prepared, reading the assigned text, doing your homework and getting involved in discussions. You will be expected to read the material indicated on the course site prior to coming to class (except for the first day of class). I praise effort, not necessarily right answers. I do not expect you to have mastered the material before coming to class (this is what we do together), but I do expect you to put in a serious effort to try and master it.

Homework: Homework will be given and solutions posted at this course site. Students are required to turn in their homework on time, by the beginning of the class, on the day the homework is due. Homework will count toward the final grade.

Midterm: Midterm will be given in class.

Final: There will be no final exam.

Project: You will be expected to do an independent project.

Grading: Grading is absolute, not on a curve. This means I will grade you based solely on your work and will not compare you to the others in the class. This is done so that you can obtain a grade based on your independent performance and not in competition with others. This also means that everyone can get an A (everyone can get an R as well, but I am hoping you will strive for better). The final grade will be calculated as follows:

- 10%: class participation
- 10%: homework
- 30%: midterm
- 50%: project.

Projects
Project format: You will be expected to complete an independent project as part of the course. You can work alone or in groups of two or three. You will have to write a paper and give a presentation at the end of the term.

Project content: You will be expected to write a 4-page conference-style paper (I will provide you with a template).
**Project presentation:** The whole class will present their projects as a BME seminar on the last day of the class. Your project will be graded based on the technical validity, written part and the oral presentation.

**Policies on cheating**

Please make sure you read this section. Often, students caught cheating claim they did not know they were doing anything wrong. That is why I took the time to spell out what is and what is not acceptable. By enrolling in this course, you acknowledge that you have read and understood these rules and will abide by them.

I encourage collaboration in this course. That is why I encourage you to do your projects in groups. I also encourage you to discuss problems in class as well as homework problems. Ultimately, I assume you are taking this course because you want to learn the material and come one step closer to being an independent researcher. Therefore, I will also assume that you will do your best to come to the solutions mostly on your own.

Following standard practice in scientific publishing, I will ask that every homework you hand in have an Acknowledgment section. This section should detail your collaboration on that specific homework. Make sure you let me know if you gave help and to whom, received help, discussed the solution or got to the solution together. I will not penalize you for collaborating. I will penalize you though, if you collaborate and do not let me know.

Similarly, collaborating with someone else than your partner on your project is fine in the following areas: help with code, help with literature, brainstorming ideas towards a possible solution. Again, as for homework, in the Acknowledgement section, make sure you put down all the people who were involved in the work. This is standard practice in scientific journals.

Most of you are coming to class to learn and will not descend to cheating. For a tiny fraction to whom this does not apply: As a rule of thumb, if you are handing in something you do not understand, you probably cheated. If you are allowing someone to copy a solution from you, you cheated. Any collaboration during midterm is strictly prohibited and constitutes cheating.

If you are unsure if something is or is not allowed, check with me. If you are at the point where you are considering cheating because you just cannot do it on your own, contact me. We will figure out a way for you to succeed in this course.

If I suspect that someone has cheated in class-related work, I will look into it on an individual basis. Penalty will also be based on individual circumstances as well as on your response to the situation. If you inform me on your own that you cheated or are unsure if you did, I will certainly be more lenient than if I discover it myself and have to confront you.

Please read the University Policy on cheating.

**Useful links**

Introduction to Matlab
### Relation of Class to ABET Criteria

<table>
<thead>
<tr>
<th>ABET Criteria</th>
<th>Relation of Class to Criteria</th>
<th>Mechanism</th>
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<tbody>
<tr>
<td>Ability to apply knowledge of mathematics, science, and engineering</td>
<td>Primary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<tr>
<td>Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td>
<td>Primary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<tr>
<td>Understanding of professional and ethical responsibility</td>
<td>Tertiary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<tr>
<td>Ability to communicate effectively</td>
<td>Secondary</td>
<td>Lectures, Class assignments, Class project and paper</td>
</tr>
<tr>
<td>Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</td>
<td>Tertiary</td>
<td>Lectures, Class assignments, Class project and paper</td>
</tr>
<tr>
<td>Recognition of the need for, and an ability to engage in life-long learning</td>
<td>Secondary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<td>Knowledge of contemporary issues</td>
<td>Tertiary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<tr>
<td>Understanding of biology and physiology</td>
<td>Tertiary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<tr>
<td>Capability to apply advanced mathematics (including differential equations and statistics), science, and engineering to solve the problems at the interface of engineering and biology</td>
<td>Primary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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<tr>
<td>Ability to address problems associated with the interaction between living and non-living materials and systems</td>
<td>Secondary</td>
<td>Lectures, Class assignments, Class project and paper</td>
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