Modern Digital Communications: A Hands-On Approach

General Information

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- Course material of Prof. Bixio Rimoldi -

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Course Web Page: `http://moodle.epfl.ch`

Why a Hands-On Course

Confucius (551-479 BC) has summarized it well in the following proverb:

> I hear and I forget,
> I see and I remember,
> I do and I understand.

In This Course Hopefully You Will

1. Consolidate what you have learned about digital communications.
2. Improve your MATLAB/Python skills.
3. Become aware of practical issues that are neglected in the PDC course (*Principles of Digital Communications* - EPFL, 6th semester).
4. Acquire the feeling that, given enough time, you could implement a communication system based on software-defined radio.
5. Expand your digital communications knowledge (OFDM, software-defined radio, GPS, fading channels, etc.).

Weekly Workflow

The focal point of the course are the lab assignments. Every week we will:

- Comment as we see fit on the previous lab assignment.
- Review the theory and/or acquire new background material for the next lab assignment.
- A typical assignment is to develop MATLAB/Python code that implements key modules of a sender and/or a receiver.
- Work at the new assignment during lab time.
- The homework consists of completing the assignment (typically one or two weeks).

What We Expect From You

- You write your own code.
- Make a reasonable effort to find and correct the bugs in your program (if any). Often they happen at places where there is something for you to learn.
- Pay attention to the program structure, documentation, and running speed.
- Uploading your solutions is optional (we provide a link on moodle). But it can be very useful in helping you to stay on track with the class and not to fall behind.

Exercise Sessions: Be Proactive, Collaborate

- Collaboration is encouraged. We learn a lot from others. We acquire new knowledge by asking questions and we consolidate our knowledge by giving explanations. In particular ...
  - You can ask for clarifications about the theory and the assignment.
  - Ask for a hint if you are stuck.
  - Ask someone to take a look at your code if you are unable to find/fix a problem.
  - But as a general rule, try as much as possible to write your own code. That is the best way to learn.

How We Evaluate

- We will have a Midterm (worth 40% of the total) and a Final Exam (60%). The Midterm is on Wed. Nov. 5 and the Final on Wed. Dec. 17 (last day of class).
- The exams are mostly based on variations of what has been asked in the homework assignments.
- If the code you have written for the weekly assignments is clean, bug-free, and is the result of your own efforts, then you should do well in the exams.
- For the midterm, you are allowed to use one A4 sheet (one single-sided page) of handwritten notes. For the final exam, you are allowed twice as much.
- Homework is not graded. (We have given the same assignments in the past and solutions are out there.)

Background

We assume that you are familiar with the content of PDC: *Principles of Digital Communications* (EPFL, 6th semester) (or equivalent courses).

Supporting Material:

1. Background material not covered in a standard course in digital communications will be presented in class.
2. Additional notes will be put on the web as needed.

To Know More: Ask us for additional reading.

Approximate Course Content

1. Introduction [1 week]
    - general Info
    - software-defined radio
    - review Fourier
    - AM modulation
    - (MATLAB/Python)
2. Building a simple communication system [3 weeks]
    - symbol- and sample-level implementation
    - eye diagram and symbol synchronization
3. GPS [3 to 4 weeks]
    - signal description and decoding
    - system description and positioning

4. Midterm Exam

5. OFDM [3 weeks]

    - basic setup
    - MMSE channel estimation
    - OFDM implementation on USRP (universal software radio peripheral)

6. Communication in the presence of fading [1 week]

    - Rayleigh channel
    - diversity
    - Alamouti scheme

7. Final Exam on the last day of class