Course guides
230379 - MCC - Modern Channel Coding

Last modified: 28/05/2020

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

Academic year: 2020 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Lamarca Orozco, M. Meritxell

Others:

PRIOR SKILLS

Digital communications

TEACHING METHODOLOGY

Lectures
Matlab simulations

LEARNING OBJECTIVES OF THE SUBJECT

This seminar provides an introduction to the techniques employed in the channel coding stages of all current and next generation communication standards. Under the common tag of "modern channel coding" there is a myriad of channel codes that share their ability to operate very close to the channel capacity with affordable decoding complexity. Since the advent of Turbo codes in 1993, the re-discovery of LDPC codes in 1996 and the invention of Polar codes in 2009 the performance of the channel coding stages improved greatly and has approached the theoretical limits very closely.

This seminar aims at presenting these families of channel codes, focusing on the algorithms employed to encode/decode them and on the tools employed to analyze and predict their performance without the need of costly MonteCarlo simulations. The codes in the most recent standards such as 5G will be discussed. These topics can be analyzed under a unified view that can be employed in a much broader range of applications; the seminar will conclude with the presentation of some examples on how to apply the tools that have been presented to other problems such as multiuser detection, demodulation etc.

STUDY LOAD

Type	Hours	Percentage
Hours large group	20,0	26.67
Self study	51,0	68.00
Hours small group	4,0	5.33

Total learning time: 75 h

CONTENTS

1. Introduction

Description:
Channel coding and modulation stages. Fundamental performance limits. Turbo codes, LDPC codes and Polar codes.

Full-or-part-time: 5h
Theory classes: 2h
Self study : 3h

3. The MAP Principle in detection

Description:
MAP detection. Graphical models in detection: factor graphs. Belief propagation.

Full-or-part-time: 14h
Theory classes: 4h
Laboratory classes: 1h
Self study : 9h

3. LDPC codes

Description:
Code design and characterization. Sum-product decoding. EXIT charts and density evolution.

Full-or-part-time: 29h
Theory classes: 7h
Laboratory classes: 2h
Self study : 20h

4. Polar codes

Description:
Code design. Decoding algorithms.

Full-or-part-time: 21h
Theory classes: 4h
Laboratory classes: 2h
Self study : 15h

5. Applications

Description:
Other applications of iterative detection: multiuser detection, turbo-demodulation, etc.

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

GRADING SYSTEM

Assignments 100%

BIBLIOGRAPHY

Basic:
- Ryan, W.E.; Lin, S. Channel codes: classical and modern. Cambridge [etc.]: Cambridge University Press, 2009. ISBN 9780521848688.
- Gazi, Orhan. Polar Codes : A Non-Trivial Approach to Channel Coding [on line]. Singapore: Springer, 2019 [Consultation: 08/07/2020]. Available on: https://doi.org/10.1007/978-981-13-0737-9. ISBN 9789811307379.
- Mackay, David. Information theory, inference, and learning algorithms. Cambridge, UK ; New York: Cambridge University Press, cop. 2003. ISBN 0521642981.

Complementary:
- Richardson, Thomas J; Urbanke, Rüdiger. Modern coding theory. Cambridge: Cambridge University, 2008. ISBN 9780521852296.

RESOURCES

Other resources:
Lecture slides
Matlab software