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230611 - IT - Information Theory

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional)

ECTS credits: 5 Teaching languages: English

Teaching staff

Coordinator: JAVIER RODRÍGUEZ FONOLLOSA

Others: JAVIER RODRÍGUEZ FONOLLOSA

Prior skills

Knowledge of random variables and probability.

Degree competences to which the subject contributes

Specific:

1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.
2. Ability to design and dimension transport, broadcast and distribution networks for multimedia signals

Transversal:

3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Teaching methodology

- Lectures.
- Problems solved individually or in groups by the student.
- Presentation of a journal paper previously agreed with the professor by the student individually.

Learning objectives of the subject

Understanding the general principles and the most common tools in the field of information theory and its application to formulate the fundamental limits of source and channel coding, both point-to-point and distributed or multiuser.

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Study load

Total learning time: 125h	Hours large group:	39h	31.20%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

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Content

Introduction

Learning time: 3h 07m
Theory classes: 1h
Self study : 2h 07m

Description:
Introduction to the field of Information Theory. Course contents, organization and grading.

Information Measures and typicality.

Learning time: 12h 30m
Theory classes: 4h
Self study : 8h 30m

Description:
Entropy, joint entropy, conditional entropy, relative entropy, mutual information, typical sequences, jointly typical sequences, properties, inequalities, stochastic Processes, Markov Chains and entropy rate.

Point-to-Point Information Theory

Learning time: 37h 30m
Theory classes: 12h
Self study : 25h 30m

Description:
Channel coding, packing lemma, channel coding with input cost, Gaussian channel, lossless source coding, lossy source coding, covering lemma, quadratic Gaussian source coding.

Distributed lossless compression

Learning time: 9h 23m
Theory classes: 3h
Self study : 6h 23m

Description:
Outer bound of the optimal rate region, Slepian-Wolf Theorem, Achievability proof of the Slepian-Wolf Theorem.

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Multiple Access Channels, Broadcast Channels and Interference Channels	Learning time: 46h 52m Theory classes: 15h Self study : 31h 52m

Description:
Discrete Memoryless Multiple Access channel, broadcast channel and interference channel, simple capacity region bounds, time sharing, capacity region, Gaussian Channels.

Information Theory Secrecy.	Learning time: 12h 30m Theory classes: 4h Self study : 8h 30m

Description:
The Wiretap channel, confidential communication with shared key, wiretap channel with secret key.

Planning of activities

Exercises.	Hours: 6h Self study: 6h

Description:
Exercises to strengthen the theoretical knowledge. A set problems to be solved individually or in groups (maximum three students per group) will be available after each chapter.

Paper presentation.	Hours: 6h Guided activities: 6h

Description:
The student will prepare a slide presentation of a journal paper of his choice related to Information Theory previously agreed with the professor. The presentation must be prepared using the provided LaTex template. Preparation of the presentation slides is mandatory but actual delivery of the presentation at the final exam day is optional. There is no final exam.

Qualification system

- Exercises (60%)
- Journal paper presentation (40%)

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Bibliography

Basic:

El-Gamal, Abbas; Kim, Young-Han. Network information theory. Primera. Cambridge: Cambridge Univerisity Press, 2011. ISBN 978-1-107-00873-1.

Complementary:

Cover, T.M.; Thomas, J.A. Elements of information theory. 2nd ed. New York: John Wiley & Sons, 2006. ISBN 978-0-471-24195-9.

MacKay, D.J.C. Information theory, inference, and learning algorithms. Cambridge, UK ; New York: Cambridge University Press, 2003. ISBN 978-0521642989.

Yeung, R.W. A first course in information theory. New York: Springer, 2002. ISBN 978-0306467912.