

# Information Theory

First Quarter, Course 2009 - 2010

## Professor

	Email	Office	Tel.
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## Time and location of Lectures

Days	Time	Classroom
Wednesdays	12:00 - 13:30	Seminar Room (IRTIC)
Wednesdays	15:00 - 16:30	Seminar Room (IRTIC)

## Tutorships

Days	Time	Office
Mondays	15:00 - 16:00	IRTIC

## Main objectives

- Learn the main statistical tools that are used in multi-user information theory and coding.
- Understand the formulation of problems from the point of view of both theoretical limits and practical designs.
- Understand the intuition obtained from the achievability Theorems in order to build optimal codes.
- Understand the proofs of the main Theorems (achievability and converse), as well as their application to different types of examples.
- Understand also the key ideas behind practical code designs with a moderate complexity.

Of course, I also expect you to enjoy the class and to be participative!

## Prerequisites

You are expected to have knowledge on Calculus, Algebra, Basic Probability, Basic Random Processes and Basic Programming.

## Class material and Web access

- Slides, which will be distributed periodically and posted at <http://pizarra.uv.es>
- Homework assignments. Although in-group discussion can be done and is ok, you should try to solve all the problems individually. When preparing the exam, I will assume that you have done all the problems. The general type of problems will not be plug-and-chug, that is, it will require time and thinking, not just applying straightforward or standard methods. Each homework assignment

will have also a given due date and no late homeworks will be accepted. Doing the homeworks will be the best possible preparation for the final exam. The homework assignments will be also posted at <http://pizarra.uv.es>

- Research papers and other complementary material, which will be posted also at <http://pizarra.uv.es>

## Project

- Research or deeper study on a related topic
- A list of papers and topics will be provided (students can also propose topics ; ) )
- Groups of two students (individual projects are also possible)
- Presentation during last week of the Quarter
- Project report due 23/12/09 (Wednesday), both content and presentation will be evaluated.

## Final Exam

There will be a Final exam on 16/12/09 (Wednesday). The set of problems and questions in the exam will be of similar level to the homework assignments.

## Grading

The final grade for this course will be calculated as follows:

$$\text{Grade} = 0.3 \times (\text{Homeworks}) + 0.3 \times (\text{Project}) + 0.4 \times (\text{Final Exam}).$$

## Approximate Outline

- Introduction
- Information measures and inequalities
- Weak and Strong Typicality
- Review of Source and Channel coding for single user
- Multiple-access channels
- Distributed lossless source coding of correlated sources
- Distributed lossy source coding of correlated sources
- Broadcast Channels
- Channels with state information
- (Time permitting) Interference and Relay channels

## Bibliography

- Basic Bibliography:
  - T.M. Cover, J.A. Thomas. *Elements of Information Theory*, Second Edition, Wiley 2006.
  - R. Yeung. *A first course in Information Theory*, Kluwer 2002.
  - Set of slides
- Complementary Bibliography:
  - R.G. Gallager, *Information Theory and Reliable Communications*. Wiley, 1968.
  - J.M. Wozencraft, I.M. Jacobs. *Principles of Communication Engineering*. Wiley, 1965.
  - D. Mackay, *Information Theory, Inference, and Learning Algorithms*, Cambridge University Press, 2003.
  - G. Kramer, *Topics in Multi-User Information Theory*, Foundations and Trends in Communications and Information Theory, now Publishers Inc., 2008.
  - G. Keshet, Y. Steinberg, N. Merhav, *Channel Coding in the Presence of Side Information*, Foundations and Trends in Communications and Information Theory, now Publishers Inc., 2008.
  - C. Schlegel, A. Grant, *Coordinated Multiuser Communications*, Springer, 2006.
  - R. Yeung, S.-Y. R. Li, N. Cai, Z. Zhang, *Network Coding Theory*, Foundations and Trends in Communications and Information Theory, now Publishers Inc., 2006.
  - I. Csiszar, J. Koerner, *Information Theory: Coding Theorems for Discrete Memoryless Systems*, Academic Press, 1981.
  - R. M. Gray, *Entropy and Information Theory*, Springer-Verlag, 1990  
(Revised version available on-line from R. M. Gray's web page at Stanford)
  - T. Berger. *Rate-Distortion Theory: A Mathematical Basis for Data Compression*, Prentice Hall, 1971
  - C. E. Shannon, *The Mathematical theory of Communication*, U. of Illinois Press, 1963.
  - Several journal papers to be distributed in class.