# Information Theory

Spring 2007

Prof. Dr. Stefan M. Moser

## Syllabus

http://moser.cm.nctu.edu.tw/nctu/it/

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## 1 Website

There is a website which is always kept up-to-date:

http://moser.cm.nctu.edu.tw/nctu/it/

Note that all handouts and exercises that are handed out during classes will also be available for download on this page. However, while the website is available worldwide, the documents can only be downloaded from within the National Chiao Tung University and within National Tsing Hua University.

## 2 Instructor

**Stefan M. Moser**
Engineering Building IV, Room 727
phone: 03-571 21 21 ext. 54548
e-mail: `stefan.moser@ieee.org`

## 3 Time and Place

There are two lectures per week:

- Monday, 15:40–17:30, Engineering Building IV, Room 021
- Wednesday, 15:40–17:30, Engineering Building IV, Room 021

The course starts on Monday, February 26, and finishes on Wednesday, June 20. For a more detailed program see the above mentioned website. Note that the second hour on Wednesday is reserved for exercises.

## 4 Course Objective

This course is an introduction to Information Theory. We will cover the most important results concerning data compression and reliable communication over a communication channel. The course will follow approximately the following schedule:

- Introduction and basic definitions:
  - entropy

  - mutual information
  - relative entropy

- Source coding: how to compress data efficiently?
  - Kraft inequality
  - source coding theorem for a single random variable
  - Shannon-Fano codes
  - Huffman codes
  - source coding theorem for a discrete memoryless source
  - Tunstall codes
  - universal codes

- Channel coding: how to transmit data reliably?
  - Fano's inequality and data processing lemma
  - converse to channel coding theorem for discrete memoryless channel
  - AEP and typical sequences
  - channel coding theorem
  - continuous random variables and entropy
  - channel coding theorem for the AWGN channel

We hope that a student who finishes the course will be able to understand the basic principles underlying any communication or data storage system.

## 5 Prerequisites

The following lectures/topics are recommended:

- Probability
- once more Probability
- Principles of Communication Engineering I and II (preferably)
- joy in math and engineering

## 6 Textbook

The course will mainly be based on

- Thomas M. Cover and Joy A. Thomas: *Elements of Information Theory,* second edition, Wiley, 2006.

If necessary there will be additional handouts during classes.

Further references and recommended readings:

- Robert G. Gallager: *Information Theory and Reliable Communication,* Wiley, 1968.
- Raymond W. Yeung: *A First Course in Information Theory,* Kluwer Academic Publishers, 2005.
- James L. Massey: "Applied Digital Information Theory I and II," lecture notes, Swiss Federal Institute of Technology (ETH), Zurich.

## 7 Grading

Every week there will be an exercise consisting of a couple of problems that needs to be solved at home. For the understanding of the course and also as a preparation for the mid-term and final exam we highly recommend to solve the exercises! Since the material of this course is rather demanding by itself, we have decided not to further challenge the students with additional tasks like, *e.g.*, a presentation of a paper. We hope that the saved time will instead be used for solving the exercises and reading the textbook!

The grade will be an average of

- the homework (15%),
- the midterm exam (35%), and
- the final exam (50%).

The grade of the homework will not be based on the correctness of the answers, but rather on the effort the student shows in trying to solve them. To pass the course there is the additional condition that **at least 10 exercises have to be handed in**.

This course is worth 3 credits.

## 8 Special Remarks

The lecture will be held in English.