

Advanced Topics in Information Theory

Spring Semester 2012

Prof. Dr. Stefan M. Moser



Syllabus

<http://moser.cm.nctu.edu.tw/nctu/atit/>

1 Website

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

<http://moser.cm.nctu.edu.tw/nctu/atit/>

You will find there all necessary information and current announcements about this course. All handouts and exercises that are handed out during classes will also be available for download on this page. Note that while the website and the lecture notes are available worldwide, the exercises and solutions can only be downloaded from within the National Chiao Tung University (NCTU) and the National Tsing Hua University (NTHU).

2 Course Objective

This course is an advanced course in information theory. Based on the theory we have learned in the course *Information Theory* we will continue to explore the most important results concerning data compression and reliable communication over a communication channel. We will talk about multiple-user communication and lossy compression schemes. The course will cover approximately the following topics:

- Method of types.
- Large deviation theory (Sanov's theorem, conditional limit theorem).
- Strong typicality.
- Rate distortion theory.
- Error exponents in rate distortion theory.
- Multiple description.
- Rate distortion with side-information (Wyner–Ziv).
- Distributed lossless data compression (Slepian–Wolf).
- Multiple-access channel (MAC).
- Transmission of correlated sources over a MAC.

- Channels with noncausal side-information (Gel'fand–Pinsker).
- Broadcast channel.
- Interference channel.

We hope that a student who finishes the course will be able to better understand the principles underlying all state-of-the-art communication systems and the difficulties encountered when designing and trying to improve them.

3 Prerequisites

The following lectures/topics are recommended:

- Probability
- Information Theory

4 Instructor

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

5 Time and Place

There are two lectures per week:

- Tuesday, 13:30–15:20 (EF), Engineering Building IV, Room 102 (ED102)
- Thursday, 13:30–15:20 (EF), Engineering Building IV, Room 102 (ED102)

On Thursday, the second hour is reserved for exercises. The course starts on Tuesday, 21 February 2012, and finishes on Thursday, 21 June 2012. For more detailed program see the above mentioned website.

6 Office Hours

NCTU requests that every teacher offers two hours per week where students may come to ask questions. The exact time will be announced on the class' website.

However, we would like to encourage you to show up in the teacher's or teaching assistant's office at any time in case you have questions about the class or related subjects. Moreover, we are always available during and after classes and particularly in the second hour on Thursday (the "exercise" hour).

7 Textbook

The course will follow my own lecture notes:

- Stefan M. Moser: *Advanced Topics in Information Theory (Lecture Notes)*, version 1, spring semester 2012.

These lecture notes will be distributed free of charge to all registered students of the course during the first week of the semester, and they are available online for download.

Further references and recommended readings:

- Claude E. Shannon: “A mathematical theory of communication,” Bell System Technical Journal, vol. 27, pp. 379-423 and 623-656, July and October 1948.
- Gerhard Kramer: *Topics in Multi-User Information Theory*, Foundations and Trends in Communications and Information Theory, vol. 4, nos. 4-5, pp. 265-444, 2007.
- Robert G. Gallager: *Information Theory and Reliable Communication*, Wiley, 1968.
- Imre Csiszár, János Körner: *Information Theory: Coding Theorems for Discrete Memoryless Systems*, 3rd edition, Akademiai Kiado, Budapest.
- Thomas M. Cover and Joy A. Thomas: *Elements of Information Theory*, second edition, Wiley, 2006.
- Po-Ning Chen and Fady Alajaji: “Lecture Notes in Information Theory,” Volume I & II, National Chiao Tung University (NCTU), Hsinchu, Taiwan.
- James L. Massey: “Applied Digital Information Theory I and II,” lecture notes, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland.
- Raymond W. Yeung: *A First Course in Information Theory*, Kluwer Academic Publishers, 2005.

8 Exercises

Every week, an exercise will be distributed in class. This exercise will consist of several problems that need to be solved at home and handed in during the class of the following week. A model solution will be handed out afterwards.

We believe the exercises to be extremely important and crucial to the understanding of the course. They also serve as a preparation for the exams and we therefore highly recommend to solve them. **To pass the course you need to hand in at least 10 exercises.**

9 Exams

There will be one mid-term and one final exam. The exact form (oral, written, etc.) will be decided in due time. Details about the covered material will be published in due time.

10 Grading

The grade will be an average of

- the homework and class participation (20%),
- the midterm exam (40%), and
- the final exam (40%).

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. Moreover, I will try to reward students who participate actively in the course. This course is worth 3 credits.

11 Special Remarks

The lecture will be held in English.