Course syllabus

Informationsteori
Information Theory

EITN45, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED C/D
Date of Decision: 2023-04-18

General Information

Main field: Communication Systems.
Elective for: C4-ks, C4-sec, D4-ns, E4-ks, F4, MFOT1, MWIR1, Pi4-ssr, MMSR1
Language of instruction: The course will be given in English

Aim

The aim of this course is to give the students knowledge of principles for information storage and transmission of information, and the use of binary representation of information. The course also gives knowledge of the performance and fundamental boundaries of todays and tomorrows communication systems.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to identify and formulate problems within the area of Information Theory,
- be able to classify the level of difficulty of problems related to the his/her own level of knowledge.

Competences and skills
For a passing grade the student must

- be able to show ability to handle new methods and results,
- be able to set up requirements on implementation of algorithms in the course,
- be able to realize systems for the algorithms presented in the course.

Judgement and approach
For a passing grade the student must

- be able to classify the level of difficulty of problems related to the his/her own level of knowledge,
- be aware of what parameters set up the boundaries for reliable communications as well as the compression ratio of a source.

Contents

The definition of information goes back to Shannons landmark paper in 1948. His theory of how information can be processed is the basis of all efficient digital communication systems both today and tomorrow. This course provides an up-to-date introduction to topic information theory. The course emphasizes both the formal development of the theory and the engineering implications for the design of communication systems and other information handling systems. The course includes:

- Shannon's information measures entropy and mutual information, both for the discrete and continuous case. Understanding of entropy as a measure of information and mutual information as a measure of the information that can be transmitted over a channel.
- Source coding: Optimal coding and Huffman codes, as well as universal source coding such as Ziv-Lempel coding (zip, etc.) and Huffman coding using estimation of distributions.
- Typical sequences, Source coding theorem and Channel coding theorem, where the former describes how much a source can be compressed and the second shows the capacity of a channel.
- Channel coding: Principles of error detection and correction on a noisy channel, mainly illustrated by Hamming codes.
- Gaussian channel: Continuous sources and additive white noise over both band limited and frequency selective channels, with examples like OFDM and MIMO. Derivation of the channel capacity and the fundamental Shannon limit.
- Discrete input Gaussian channel: Maximum achievable rates for PAM and QAM, Coding and Shaping gain, and SNR gap.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Hand in problems and home exam.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0118. **Name:** Information Theory.
Credits: 5. **Grading scale:** TH. **Assessment:** Hand in exam **Contents:** Examination for the theoretical part of the course
Code: 0218. **Name:** Hand in problems.
Credits: 2,5. **Grading scale:** UG. **Assessment:** Hand in problems **Contents:** Applications of the theory in terms of data compression and channel coding

Admission

Assumed prior knowledge: Basic course in probability theory, ETT051/EITG05 Digital Communications
The number of participants is limited to: No
The course overlaps following course/s: EIT080

Reading list

- Stefan Höst: Information and Communication Theory. IEEE Wiley, 2019, ISBN: 9781119433781.
- Additional material.

Contact and other information

Course coordinator: Michael Lentmaier, michael.lentmaier@eit.lth.se
Course homepage: http://www.eit.lth.se/course/EITN45