Course syllabus

Digital kommunikation, fortsättningskurs
Digital Communications, Advanced Course

ETTN01, 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.
Compulsory for: MWIR1
Elective for: C4-ks, D4-ssr, D4-ns, E4-ks, MFOT1
Language of instruction: The course will be given in English

Aim

The aim of this course is to give very good knowledge of advanced digital communication methods. The course gives a broad and deep understanding such that many of the communication methods used today, as well as many future methods, can be understood.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to show a significantly broader and deeper knowledge within the area of digital communications
- be able to critically analyse and describe advanced digital communication systems from an overall perspective

Competences and skills
For a passing grade the student must

- be able to identify, formulate and handle complex problems within the area of digital communications
- be able to suggest technical solutions for digital communication systems satisfying given performance requirements
- be able to independently work in a creative way with advanced projects, and also orally and in writing clearly present, motivate and discuss obtained conclusions

Judgement and approach
For a passing grade the student must

- be able to show ability to make judgements with respect to relevant scientific, social and ethical aspects

Contents

Introduction: Examples of advanced adaptive digital communication methods are introduced for realistic communication links.

Signal space description: A general geometric description of a communication link is given. Practical ML (and MAP) receivers are described in detail, and computer simulation models of a communication link are presented. The symbol error probability is calculated exactly for several signal constellations such as, e.g., PAM and QAM. The concept of diversity is explained and illustrated, and MIMO systems (multiple-input multiple-output) are introduced. The relationships between multi-path propagation, matched receiver filter and the so-called RAKE (receiver) structure are clarified. Alternative channel models and sub-optimum receiver structures are briefly discussed.

Combined coding and modulation: A state-based description of coding and modulation is introduced. Principles of OFDM are given in detail and also how modulator and demodulator are implemented efficiently. Advantages and disadvantages of coded OFDM are clarified. Shannon´s capacity results. Principles of modern communication systems are studied where the transmitter adapts (bit rate, coding and modulation) depending on the quality of the communication link. Consequences of different transmission media such as air, metallic conductors and optical fibers are discussed and compared.

Fading channels: Mobile communication. Consequences of a time-varying multi-path communication link regarding bit rate, bit error probability and communication distance is studied. Technical solutions are illustrated that are based on the very important concept of diversity. Interleaving is explained. We here also meet several common concepts related to fading channels, e.g.; Doppler shift, coherens time, coherens bandwidth, multi-path spread, frequency-selective, and Rayleigh fading.

Applications: Some of the following applications are considered in this course: Mobile digital telephony (4G, 3G, EDGE, GSM), WLAN, modem, ADSL, digital TV, Bluetooth, navigation (GPS), radar, surveillance systems.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Written examination (5 h) normally consists of five problems. Approved lab and project is a requirement to be allowed to enter the examination.

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: 0110. **Name:** Examination.

Credits: 5. **Grading scale:** TH. **Assessment:** Written exam. **Contents:** The whole course.

Code: 0210. **Name:** Project.

Credits: 2. **Grading scale:** UG. **Assessment:** Passed project work. **Contents:** Written report, oral presentation, and acting as opponent on another groups report and presentation.

Code: 0310. **Name:** Laboratory Work.

Credits: 0,5. **Grading scale:** UG. **Assessment:** Passed laboratory lesson. **Contents:** The course has one mandatory laboration.

Admission

Assumed prior knowledge: ETT051/EITG05 Digital Communications.
The number of participants is limited to: No
The course overlaps following course/s: ETT055

Reading list

- Lindell, G: Introduction to Digital Communications. 2006. Compendium.
- Lindell, G: Lecture notes on OFDM. 2015.

Contact and other information

Course coordinator: Johan Thunberg, johan.thunberg@eit.lth.se
Course homepage: http://www.eit.lth.se/course/ettn01