Course PM

SSY305 Kommunikationssystem

2022/23

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Abstract

This document describes the course *SSY305 Kommunikationssystem*.

Any changes to the information in this document will be posted on Canvas at:

https://chalmers.instructure.com/courses/22508

Contents

General Information

Schedule
Available in TimeEdit:
https://cloud.timeedit.net/chalmers/web/s1/ri17566610000YQQ86Z0597007y8Y5103gQ5g1X6Y65ZQ766tZ5Qd5203E656Z945164362C3Bt7700AE82251E92Q.phtml

Text
B. Forouzan, *Data Communications and Networking*, 5th Edition, McGraw-Hill, 2013, ISBN 978-981-4577-51-9.
Will be available at Cremona. Appendices, errata, and other extra material can be found at www.mhhe.com/forouzan

Additional printed material
Additional material will be made available for download from Canvas.

Exam
Registration is mandatory for exams. Students that do not register for the exam in time will not be allowed to take the exam.

Exam date	Venue	Results	Grading Reviews
March 16, 2023, PM	Campus Johanneberg	To be announced on Canvas	To be announced on Canvas

Projects
There is a mandatory project in the course. Details are found on page 5.
The project deadline is Thursday, February 23, 2023xf, at 22:00.

Quizzes
There are six quizzes in the course. Details are found below on page 6.

Email subject line
Please include the string "[SSY305]" in the subject line of all course-related emails.

Lecturer
Paolo Monti, room 6416, mpaolo@chalmers.se (for lectures 1-3, 8-18).
Erik Ström, room 6412, erik.strom@chalmers.se (for lectures 4-7).

Guest Lecturers
- E-health: Stefan Candefjord, stefan.candefjord@chalmers.se
- Smart grid: Jimmy Ehnberg, jimmy.ehnberg@chalmers.se
- Distributed control systems: Samuel Winther Samuel.Winther@vector.com, Vector Sweden
- Cooperative traffic safety: Erik Ström, erik.strom@chalmers.se

Teaching Assistants
Morteza Barzegar Astanjin, room 6414, mortezab@chalmers.se
Office hours are scheduled on Thursdays, 15:15-17:00.

E2 Student Administration Office
Christina Lidbeck, Phone 772 4611, christina.lidbeck@chalmers.se.

Prerequisites

The course assumes students have a working knowledge of basic concepts in

- signal processing (linear filtering, convolution, impulse response, frequency response, Fourier transforms)
- probability (probability density functions, probability, expectation)

The prerequisites can be acquired by passing TMA981 "Linjära system och transformer" and ESS011 "Matematisk statistik och signalbehandling," or similar courses.

A short review of signals and systems in the form of a written document and a few video lectures is available at Canvas.

Aims and Learning Outcomes

Aims

There are two main aims of this course.

The first is to provide a broad introduction to communication systems as the enabler of information and communication technology (ICT) applications, e.g., E-health, smart grid, automation, process control, and traffic safety, to mention a few. A modern engineer in any field will interact with ICT systems. However, when specifying the requirements of a communication system to support a specific ICT application, the non-communication engineer would benefit tremendously from knowing the terminology, possibilities, and limitations of communication systems.

The second aim is to provide a solid introduction to communication systems for the student planning a career as a communication engineer. We will treat, in some detail, the lower layers of the communication stack. In other words, we are mainly concerned with the basic task of transmitting packets of bits from point A to point B over a physical medium (e.g., a piece of fiber optical cable or a wireless channel). Once we master this task, the communication links will be used to form complex networks, such as the Internet, that are so important today.

Learning Outcomes

After the course, the students should be able to

- describe how sustainable development is facilitated by communication
- describe the purpose of the layers in the OSI model for communication, with emphasis on the network, data link, and physical layers
- describe the purpose of the main components in the TCP/IP protocol suite
- analyze the requirements an ICT application (e.g., E-health, smart grid, automation, process control, or vehicular traffic safety) poses on a communication system
- explain the blocks in Shannon's model for digital communication
- define and compute performance metrics for communication
    - error probability
    - spectral efficiency
    - power efficiency
    - latency
    - throughput
- explain the concepts of symmetric cryptography, asymmetric cryptography, and hash-functions and how these can be used to provide confidentiality, integrity, and authentication

Content

The content of the course is listed below. A detailed week plan is available on Canvas.

- Introduction to Information and Communication Technology (ICT) applications: E-health, automation, process control, smart grid, cooperative traffic safety
- Introduction to the OSI model for communication
- Introduction to TCP/IP protocol suite and relation to the OSI model
- Shannon's model for digital communication: source coding, error-control coding, modulation
- Physical layer
    - Modulation: bits, symbol, constellation diagrams, pulse amplitude modulation, quadrature modulation
    - Matched filter, maximum-likelihood detection
    - Performance metrics: symbol error probability, spectral efficiency, power efficiency
- Error probability for an additive white Gaussian noise channel
- Introduction to coding for error correction and error detection
- Link layer
    - Medium access control: ALOHA, CSMA, TDMA, FDMA
    - Retransmission protocols: ARQ
    - Performance metrics: packet error probability, throughput, latency, fairness
- Network layer: Introduction to routing, addressing, forwarding
- Transport layer: Introduction to flow control, congestion control
- Security: introduction to confidentiality, integrity, and authentication
- Review and summary of the course

Lectures

The objective of the lectures is to highlight the most important parts of the course. However, we do not aim (and there is not enough time) to cover all relevant aspects in all detail. Most of the learning takes place outside the lecture hall, and the number of lectures has therefore been reduced to free up more time for group and individual work.

Guest lectures by invited experts will highlight special parts of the course. The presented material is part of the learning outcomes and will therefore be assessed (e.g., at quizzes, project, and/or exam).

Exercises

The exercises will be conducted in a form that may feel unconventional. The purpose of the exercises is not to solve many standard problems at high speed. Instead, the goal is to facilitate learning and understanding of the course material. The ability to solve standard problems does not imply understanding. However, understanding gives problem-solving skills.

It is essential that you come prepared for the exercises, i.e., that you have read the relevant sections of the course book and perhaps also solved some of the suggested exercise problems.

It is also crucial that you are active during the exercises. Always try to understand what aspects of the course the problems are treating. Ask the assistant if you cannot see the point of a specific problem! There is a meaning behind every problem in this course.

A typical exercise will be started with a short review of the theory and motivation for why the theory is of use for a communications engineer. Next, the assistant may solve a problem on the blackboard, and then the students will be asked to solve a few

problems in groups of four. Finally, the assistant will visit the various groups to discuss the solutions and resolve any misunderstandings.

Project

The course has a mandatory project. The project is carried out in groups of three students assigned by the teaching staff. Cooperation between the groups is considered cheating and is subject to disciplinary actions. An assistant will be available for consultation, and the assistant will also approve and grade the project.

The purpose of the project is to facilitate learning of the course material. All team members *should contribute equally* towards accomplishing the project tasks. Even if the work is split between group members, the group members are collectively responsible for the results. They should be able to answer detailed questions about any part of the project.

The project consists of three parts. The solutions to the first two parts are documented in a report and defended at an oral exam. The third part is examined based on an oral slide presentation.

Report guidelines

The two first parts of the project should be documented in a short report, due a few days before the oral exam. **Reports handed in after the deadline will not be considered**.

The report should be written in English and comply with standard practices for technical reports. See Chalmers Writing Guide at http://writing.chalmers.se/en. In addition, it should fully document the project, i.e., explain what was done, why it was done, who did what, and what the results were.

Furthermore, the results should be commented on and checked to be reasonable and consistent with each other and the relevant theory. Plots must be clearly labeled with units. It is important not to blindly use formulas from the book without checking that the formula applies to the situation. Moreover, some of the formulas in the book are surely in error (as the case is for most books).

The report should not be longer than necessary. A report that is too long or verbose will not receive full points. Do not spend a lot of space on background material. The report's purpose is to document your work, not someone else's.

A section in the report should clearly state the members' contributions, including writing the report and MATLAB simulations.

Program code

The program code needed to solve the project should be carefully commented on and attached to the report. Writing program code is an efficient way to learn. Hence, all programs should be written from scratch. That is, copying code from the Internet or other sources is not allowed. Such practice will be caught by the anti-plagiarism system and will be treated accordingly.

Report submission instructions

Each group should submit its report via Canvas. The report will be automatically checked by *Urkund* for plagiarism.

Late reports will not be graded, and no points will be awarded to the group. The oral exams are scheduled according to a separate schedule provided by the teaching assistants. Groups sign up for the oral exam at Canvas.

Presentation of the third part

The solution to the third part of the project consists of an oral presentation with a computerized slide show (e.g., PowerPoint, Keynote, or similar software). The presentation should be in English and be 15 minutes long. All group members should speak during the presentation.
Three groups will present during a 60-minute slot—one group presents, and two groups are in the audience. The presentation slots are set according to a separate schedule provided by the teaching assistants. Groups sign up for the presentation via Canvas.

Grading

The project is graded according to the following guidelines.

- *Report:* the report should document the first two parts of the project, be concise, written in good English, easy to follow, and comply with the Chalmers Writing Guide (http://writing.chalmers.se/en). The results should be commented on and checked to be reasonable and consistent with the theory. The maximum score is **17 points**.
- *Oral exam:* all group members should be able to explain and defend all details about the project report at the oral exam. For example, suppose Student A has programmed a MATLAB function. Then Students B and C should be able to explain the code during the oral exam. The maximum score is **17 points**.
- *Presentation:* the presentation of the third part will be graded based on the criteria defined in the project description. The maximum score is **12 points**.

The report and presentation scores are common to all group members, while the score for the oral exam is assigned individually. As a result, the total project score can differ for the group members.

A report with a score lower than 7 points, an individual oral exam with a score lower than 7 points, or a presentation with a score lower than 6 points will cause the project to be graded as failed. Students failing a project will have to pass the project the next academic year.

Quizzes

Students can get points from the six quizzes given at the first exercise session in LV2-7. Quizzes will be provided and will be answered via Canvas.

Each quiz will have four multiple-choice questions to be answered in a pre-determined amount of time. Questions will have to be answered in the order they are provided, and backtracking to a question already answered will not be possible. Questions at the quiz can be from any parts of the course (lectures, exercises, etc.) that have been covered until the quiz date. A correct answer will give 1/4 point. There is no penalty for a wrong answer.

It is important to remember that cooperation while answering quizzes is considered cheating and is subject to disciplinary action.

The quiz points during the course are summed and rounded up to the nearest integer. Hence, the total quiz score is an integer from 0 to 6.

Written Exam

The course will be concluded with a written exam with four problems. Each problem yields a maximum of 12 points. An incorrect answer, incomplete or poorly motivated solutions give point reductions down to a minimum of 0 points. A minimum score of 20 is needed to pass the exam. The maximum score is **48 points**.

As a general rule, bad motivation or errors that relate to fundamental principles of the

course will lead to significant point reductions. On the other hand, computational errors that do not lead to unreasonable answers generally give smaller reductions.

The purpose of the problems in the exam is to test to what degree the students have reached the aims and objectives (see Section *Aims and Learning Outcomes* on page 2). It will, therefore, not be possible to solve the exam problems by just finding the correct formula on the note sheet or by remembering and imitating the solution of one of the exercise problems. The course is about *understanding,* not *memorizing* the course material.

Final Grades

To pass the course, the project and the exam must be passed.

- The project is passed by securing at least
    - 7 points for the report,
    - 7 points for the oral exam, and
    - 6 points for the presentation
- The exam is passed by securing at least 20 points

The sum of the scores from the project (max score 46), quizzes (max score 6), and final exam (max score 48) will decide the grade according to the following table.

Total Score	0–39	40–68	69–79	≥80
Grade	Fail	3	4	5