



## HÖGSKOLAN I GÄVLE

### Modulation and Coding 7.5 cr

*Modulation och kodning 7,5 hp*

Set by Board of Technology and Built Environment

**Version**

**Set at**

**Valid from**

9/26/07

**HT2007**

<b>Level</b>	A1F
<b>Education level</b>	Second cycle
<b>Course identifier</b>	EE443D
<b>Credits</b>	7.5 cr
<b>Main field of study</b>	Electronics
<b>Subject group</b>	Electronics
<b>Disciplinary domain</b>	Technology 100.0 %

**Learning outcomes**

The aim of the course is to give knowledge of systems for transmission of electrical signals by dealing with the fundamental theories and applications of digital communication systems from a signal processing point of view.

After finished course the student is expected to:

- Understand and have a good overview over how a digital communication system is working
- Be capable to design and calculate the overall performance of a digital communication system from given fundamental properties and limitations
- Understand and capable to describe the theory behind information transmission of electrical signals
- Adequately describe the different blocks in a digital communication system and understand their contribution to the whole system
- Be capable of implementing digital transmitters and receivers in software
- To some extent be capable of benefiting from scientific reports
- Be capable of finding relevant information on the Internet

**Course content**

- Introduction to information theory
- Information measures, Channel capacity, and channel models
- Source coding and data compression

Shannon's coding theorem, Huffman coding, predictive coding, and the Lempel-Ziv algorithm

- Representation of band-pass signals and systems
- Linear digital modulation methods  
PAM, PSK, QAM, and FSK
- Nonlinear digital modulation methods  
Continuous-phase modulation
- Spectrum of modulated signals
- Optimum receivers in AWGN  
The Correlation- and matched filter demodulator, optimum detectors, Viterbi algorithm
- Performance calculations  
The Q-function, union bound, and decision boundaries
- Channel coding  
Block coding and decoding, convolutional coding and decoding
- Performances of forward error correcting coding
- Comparison of different modulation methods  
Spectral efficiency, Shannon's limit
- Introduction to spread-spectrum communication  
Direct sequence spread-spectrum signals, frequency-hopped s. s. signals, processing gain, and jamming margin
- Aspects as spectrum efficiency and energy consumption from a sustainability development point of view

<b>Teaching</b>	The education is performed as lectures, exercises, and laboratory work/assignments. The laboratory work/assignments is normally performed in groups of two students. Emphasis is put on the students capability of accomplishing and reporting the work. The lectures and exercises are not mandatory for the student. However, participation in laboratory work and assignment tasks is mandatory.			
<b>Prerequisites</b>	B.Sc. degree in Electronics, Electrical Engineering or equivalent. Statistical Signal Processing or equivalent.			
<b>Examination</b>	Examination is based on: 5 Problem sessions Laboratory exercise: 156E Digital radio link			
<b>Grade</b>	A, B, C, D, E, Fx, F			
<b>Limitations</b>	For each course two examination opportunities are offered: one at the end of the course and one extra. Laboratory reports are due not later than a week after the scheduled occasion of the task if otherwise is not announced. Late reports are not considered until the next time the course is given (normally a year later). The report is marked by approval through the signature of the laboratory supervisor. In case of rejection, the report has to be revised by the student in agreement with the supervisors comments. For assignments, approved results are required. The deadline for assignment reports is decided by the examiner.			
<b>Other regulations</b>	A written examination is offered at the end of the course. In addition, approved results from laboratory exercises and assignments are required.  A course certificate is issued if requested by the student, provided that the course is completed and examination results are approved.  Certificate of the course is only awarded after completed and approved course and only upon the student's request.			
<b>Sustainable environment</b>	A minor part of the course content deals with sustainable development.			
<b>Module</b>	0010	Written examination	5.4 cr	Grade: AF
	0020	Laboratory exercise	0.6 cr	Grade: AF

0030	Assignments	1.5 cr	Grade: AF
0040	Written Examination	6.9 cr	Grade: TH
0050	Laboratory exercise	0.6 cr	Grade: UG