INSTITUTE OF TECHNOLOGY
LINKÖPINGS UNIVERSITET

Exam in TSKS04 Digital Communication Continuation Course

Exam code:	TEN1
Date:	2015-06-08 **Time:** 14:00–18:00
Place:	TER4
Teacher:	Mikael Olofsson, tel: 281343 (examiner and creator: Emil Björnson)
Visiting exam:	15
Administrator:	Carina Lindström, 013-284423, carina.e.lindstrom@liu.se
Department:	ISY
Allowed aids:	Olofsson: *Tables and Formulas for Signal Theory* Upamanyo Madhow: *Fundamentals of Digital Communication*, Cambridge University Press, 2008.
Number of tasks:	5
Solutions:	Will be published within some days after the exam at http://www.commsys.isy.liu.se/TSKS04
Result:	You get a message about your result via an automatic email from Ladok. Note that we cannot file your result if you are not registered on the course. That also means that you will not get an automated email about your result if you are not registered on the course.
Exam return:	2015-06-26, 12.30–13.00, in the office of Emil Björnson, Building B, Corridor A, between Entrances 27–29. After that in the student office of Dept. of EE. (ISY), Building B, Corridor D, between Entrances 27–29, right next to Café Java.

Important: Solutions and answers must be given in English.

Grading: This exam consists of five problems. You can get up to five points from each problem. Thus, at most 25 points are available. Grade limits:

- Grade three: 12 points,
- Grade four: 16 points,
- Grade five: 20 points.

Sloppy solutions and solutions that are hard to read are subject to hard judgement, as are unreasonable answers.

1 Let the input to a digital linear modulator consist of independent, equally probable bits. Consider an on-off keying signal constellation with the signal variance P. Determine the power-spectral density when the basis function is (5 p)

$$\phi_1(t) = \cos(2\pi f_c t), \quad 0 \leq t < T,$$

where $2f_cT$ is a positive integer.

2 Solve Problem 4.7ac on page 194 in Madhow. (5 p)

3 Find and sketch the decision regions for a binary hypothesis testing problem with observation Z, where the hypotheses are equality likely, and the conditional distributions are: (5 p)

H_0: Z is uniformly distributed between -2 and $+2$.

H_1: Z is Gaussian distributed with mean 0 and variance 1.

Exact equations for the decision boundaries should be provided.

4 Consider a channel where the received signal is given by (5 p)

$$y(t) = \sum_{n=-\infty}^{\infty} b[n]p(t-n),$$

where $\{b[n]\}$ is a symbol sequence from a BPSK modulation (i.e., $b[n] \in \{-1, +1\}$). The pulse p is given by

$$p(t) = \begin{cases} 2, & 1 \le t < 2 \\ -1, & 2 \le t < 3 \\ 1, & 3 \le t < 4 \\ 0, & \text{elsewhere.} \end{cases}$$

a. Compute the sampled autocorrelation sequence of the pulse p.

b. Suppose that $b[n] = +1$ for all $n \le 0$. Use the Viterbi algorithm to compute ML estimates of the received symbols $b[n]$ for $n = 1, \ldots, 4$, assuming that the matched filter outputs are $z[1] = 1$, $z[2] = -3$, $z[3] = 0$, $z[4] = -2$. Terminate the algorithm by selecting the state at time $n = 4$ with the highest end probability.

5 Solve Problem 7.7 on page 371 in Madhow. (5 p)